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DOCUMENT PROCESSING SHEET



WT-569

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No. 21 of 70 copies, Series A

10-4995-066

Report to the Test Director

### TECHNICAL PHOTOGRAPHY

**Operation Tumbler-Snapper** 

Ву

Herbert E. Grier

and

Staff

Classification (Canadated) (Changed to 1766) (By Authority of 110 1381 (SUPPL) 3 (Dec 7)

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Edgerton, Germeshausen & Grier, Inc. By L. W. Boston, Massachusetts
April 1954

By L. Miles Ci. ISC m 300cc 80

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# ERRATUM FOR TUMBLER-SNAPPER PROJECT 12.1 REPORT (WT-569)

Owing to an error made in transcribing information furnished by Test Organization, J-Division, Los Alamos Scientific Laboratory, the Errata (September 30, 1954) for the above report contained an incorrect statement. The last correction listed should read as follows:

Pages 143-144, Appendix E:

Change unit in column heading of last column to read "meters/msec" instead of "meters/µsec."

U. S. Atomic Energy Commission Technical Information Service, Oak Ridge, Tennessee

### ERRATA FOR TUMBLER-SNAPPER PROJECT 12.1 REPORT (WT-569)

Information received after this report had been printed and bound indicates that the following corrections should be made:

Page 6, Illustrations:

Delete "Fig. 3.21 Rapatronic Collimator."

Change "Fig. 3.22" to "Fig. 3.21."

Change "Fig. 3.23" to "Fig. 3.22."

Page 38, Section 3.5.2:

Change first and second lines in first paragraph to read:

"field using the collimator"; delete first part of second
line, "pictured in Fig. 3.21. This collimator was." (The
revision will then read, "Focal lengths of the Rapatronic
cameras were measured in the field using the collimator

braced on a stand," etc.)

Page 43, Fig. 3.21:

Delete entire figure.

Page 44, Fig. 3.22:

Change to "Fig. 3.21."

Page 45, Fig. 3.23:

Change to "Fig. 3.22."

Fage 46, last line in Section 3.6:

Change "Figs. 3.22 and 3.23" to read "Figs. 3.21 and 3.22."

Pages 143-144, Appendix E:

Change unit in column heading of last column to read "meters/ sec" instead of "meters/µsec."

U. S. Atomic Energy Commission Technical Information Service. Oak Ridge, Tennessee



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# TECHNICAL PHOTOGRAPHY

Operation Tumbler-Snapper

By

Herbert E. Grier

and

Staff

Classification (Canacia) (Changed to—1864)

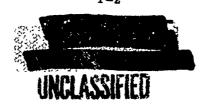
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Edgerton, Germeshausen & Grier, Inc. By L. Miles Boston, Massachusetts April 1954

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### **ABSTRACT**

For Operation Tunbler-Snapper, the technical photography accomplished by Edgerton, Germeshausen & Grier, Inc. (EG&G), Program 12.1, was as follows:

- (1) Airdrops
  - (a) Position of burst
  - (b) Fireball pictures for yield
  - (c) Ultrashort-exposure-time photography (still) Rapatronic
  - (a) Pictures for blast studies

Mortar-Jato

Gun puff

Rocket trail

Dust, preshock turbulence, light absorption, and mirage

- (e) Early cloud formation
- (f) Bomb light as a function of time
- (g) Cloud tracking (only for the shots detonated in Yucca basin)
- (h) Consultation on operation of EG&G Disc camera in the bombing airplane
- (2) Tower Shots
  - (a) Fireball pictures for yield
  - (b) Ultrashort-exposure-time photography (still)—Rapatronic and Teletronic (shots 6, 7, and 3)

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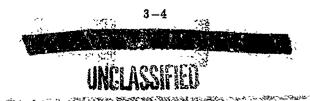
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- (c) Gun puff (shots 5 and 8)
- (d) Early cloud formation
- (e) Bomb light as a function of time

The reader is referred to the Camera Data Sheets, Appendix A, for a condensed listing of the photography which was performed. Complete data are presented in the Film Data Sheets which, because of their bulk, have been issued separately from this report.\* These Film Data Sheets list all data pertinent to cameras, lenses, films, processing, magnifications, and time scales, as well as comments on the content of the record.

Projection prints of the films were made and distributed to those requesting them, usually within a week after the detonation. In addition, a sound film illustrating and describing typical photographic data obtained during the airdrops has been issued. Appendix B is a summary of the films included in this film.

<sup>\*</sup>Tumbler-Snapper, Film Data Sheets, Vols. I, II, and III, EG&G-OUT 1013, 30 October 1952.

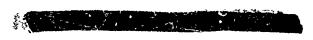


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#### CHAPTER 1

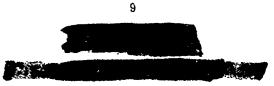
### INTRODUCTION

Photography was accomplished from four types of stations. The cloud tracking was done from two manned stations located some 25 miles from zero. The dust, preshock-turbulence, light-absorption, and mirage studies were primarily obtained from a series of stations located 200 ft off the blast line and opposite even-numbered blast poles. These stations were concrete cubicles into which a camera rack containing two cameras was inserted from the top. This access hole was sealed with a lead block. One side of the station was provided with a lead-glass window through which the pictures were taken. The cameras in these so-called "dust" stations were only about 3 ft above ground level. In an effort to provide continuing coverage after the dust caused by thermal radiation and shock arrival had obscured the field of view of these cameras, it was decided to operate a few cameras from elevated structures. The three outermost dust stations had steel pipes mounted in their roofs on the top of which a camera was operated (approximately 14 ft above the ground). In addition, use was made of two of the 25-ft towers which had been originally built by the Department of Defense (DOD) for Operation Buster-Jangle. The remaining photography was accomplished from phototrucks and phototrailers, package units that were prewired in Boston and positioned on concrete pads in areas that had been stabilized. These stations were from 2 to 3 miles from Ground Zero.

The details of location and operation of the above types of stations are given in Appendix C. The reader is referred to the Edgerton, Germeshausen & Grier, Inc. (EG&G), Operations Greenhouse and Buster-Jangle photographic reports for details on cameras, films, exposure calculations, processing and analysis methods, and general operational philosophies.

### REFERENCES

- 1. Ball-of-fire Observations, Greenhouse Report, Annex 1.4, WT-101.
- 2. Technical Photography, Buster-Jangle Project 10.3 Report, WT-417, December 1952.





CHAPTER 2

### **FILM HANDLING**

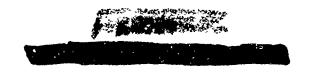
#### 2.1 PRESHOT PREPARATION

All unexposed films were stored at the Control Point (CP) building. For films that were to be used on an actual test, the following procedure was carried out. Starting on the afternoon of D-2 day, the films were removed from the storage refrigerators and allowed to come to thermal equilibrium before the seals were broken. Before loading into cameras, the following steps were taken:

- 1. An identification number was perforated into the film. This number consisted of five digits. The first two numbers indicated whether the film was to be used for calibration, dry runs, or actual tests; the 13000 series indicated the live runs for Operation Tumbler-Snapper. Since less than 100 films were exposed per shot, the third number was used to designate the particular test. (TS 1 to 5 were the 130-- to 134-- series, the missire, TS-6, was the 135-- series, and TS 6 to 8 were the 136-- to 138-- series.) The last two numbers indicated in an approximate manner the use for which the film was being exposed. Owing to program changes this can never be adhered to very strictly, although it was found that an attempt at such a system was very useful to those dealing intimately with the handling and programing of the films.
- 2. Two exposures were placed upon the head of the film. One was a gray scale to be used for sensitometric control and evaluation; the second was an accurate graticule to be used for checking relative film shrinkage during analysis of the records. The prelition of these exposures on the film had to be such that the region in question would not be light-struck during the camera loading and such that it would not interfere with the record.
- 3. The films were placed in the appropriate magazines, cassettes, cans, etc., and were carefully marked as to station and camera destination. The actual camera loading was done on the afternoon of D-1 day.

### 2.2 PROCESSING

All 16- and 35-mm black and white films, as well as sheet films (scope cameras) and glass plates (Rapatronics, phototheodolites, and survey cameras), were processed by EG&G personnel in the mobile unit set up in the CP area (Fig. 2.1). The  $9\frac{1}{2}$ -in. by 75-ft records from the K-17 cameras were processed by the Inyokern NOTS, and the 16- and 35-mm color films (Eastman Colo. Negative emulsion) were processed by Consolidated Film Industries—the 35-mm films at their Hollywood, Calif., laboratory and the 16-mm films at their Fort Lee, N. J., laboratory. The order of processing was such as to make the records for position of burst and for yield determination ready as soon as possible; the other records followed in a logical order dictated by consideration of necessary development temperature and the film size.



In running film through the processing machine, it is necessary to group the records according to the contrast or gamma desired. Consequently, each make-up spool for the processing machine contained only records on the same emulsion exposed through the same type color filter and for which the same gamma was desired. In addition to t'e sensitometric strip

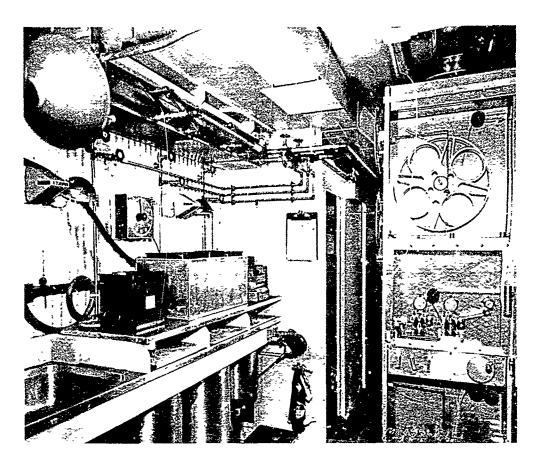


Fig. 2.1 - Interior of EG&G phototrailer.

(gray scale) placed on the films themselves, additional gray scales were spliced into the head and tail of the make-up spool. These scales were read immediately after processing to provide constant check upon the acceptability of the development. Development Data Sheets were prepared in advance of the shot to be used as programing guides and to facilitate data recording. A typical data sheet of this type is shown in Fig. 2.2.

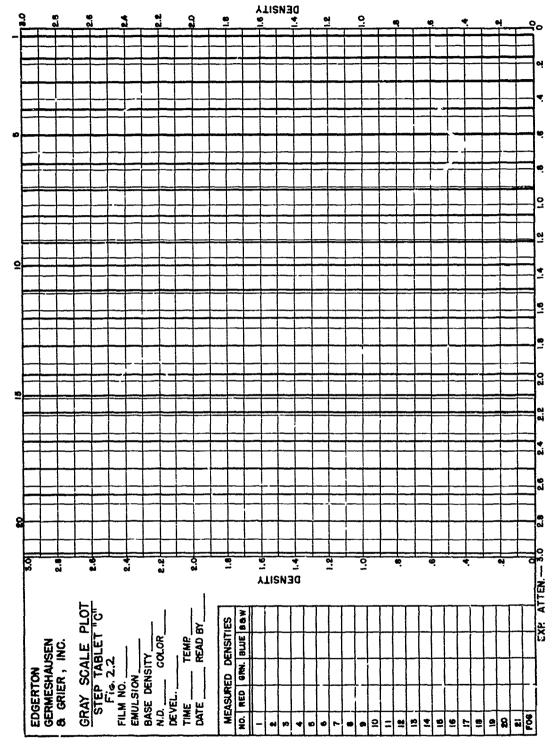


Fig. 2.2—Typical Development Data Sheet.

### FIREBALL GROWTH MEASUREMENTS FOR YIELD

### 3.1 METHODS OF SCALING

As in previous operations, EG&G used high-speed Eastman cameras and Rapatronic still cameras to determine yield. The methods of fireball scaling have been discussed at some length in reports for Operations Ranger, 1 Greenhouse, 2 and Buster-Jangle. 3

It has been determined that, for bombs greater than about a 7-KT yield, the shock front expands at such a rate that, at a time prior to minimum, the variation of diameter with respect to time may be expressed as follows:

$$D = \phi t^{\frac{2}{5}}$$

where D = diameter of fireball

 $\phi$  = a constant for all times at which the exponent of t equals 0.4

t = time in milliseconds

This may also be written

$$\phi = Dt^{-\frac{2}{5}}$$

The parameter  $\phi$  assumes a constant value prior to the minimum on bombs of yield  $\geq$  7 KT. This allows the use of the scaling laws to determine yield.

It has been found more expedient to plot

$$\log \phi = \log t + K'$$

which is a more sensitive determination of the departures from the theoretical relation of  $D = Kt^{\frac{3}{2}}$ . The plots of log  $\phi$  vs log time as applied to Tumbler-Snapper are shown in Figs. 3.1, 3.3, 3.5, 3.7, 3.9, 3.11, 3.13, and 3.15.

Thus, when the parameter  $\phi$  assumes a constant value prior to minimum, it verifies the  $t^{2/5}$  law and enables scaling of the bomb to determine the yield.

Method 1 of the Sandstone analysis, previously described, compares the yield of a known bomb with that of an unknown bomb.

$$\frac{W_1}{W_2} = \left(\frac{D_1}{D_2}\right)^5 \ \left(\frac{t_2}{t_1}\right)^2$$

where W = yield

D = diameter of fireball

t = time at which the diameter is D

Combining these we obtain

$$\frac{\mathbf{W_1}}{\mathbf{W_2}} = \left(\frac{\phi_1}{\phi_2}\right)^5$$

Accounting for differences in ambient air density,

$$\frac{\mathbf{W_1}}{\mathbf{W_2}} = \frac{\rho_1}{\rho_2} \left( \frac{\phi_1}{\phi_2} \right)^5$$

By arithmetic averaging of the  $\phi$ 's obtained from Eastman records, a scaling equation may be written

$$W = K \rho \phi^5$$

From previous known bombs the value of K is found to be  $1.294 \times 10^{-8}$ . Therefore, to obtain yield:

$$W \approx 1.294 \times 10^{-8} \rho \phi^5$$

where W = total energy release

 $\rho$  = air density of burst

 $\phi^5$  = (average  $v_i$ : 1e of diameter)<sup>5</sup> (meters) divided by (time)<sup>2</sup> (millisecords) for all times of 0.4 slope

The above method was applied directly to TS 3 to 8. The resulting plots of  $\phi$ 's vs time and diameters vs time may be found in Figs. 3.1 to 3.18.

The first two bombs, TS 1 and 2, were of such low order as to forbid the use of the normal scaling laws. It was therefore necessary to compare the diameters obtained for these tests with those of Ranger A, also a low-order bomb (see Fig. 3.19).

The situation was hampered on TS-1 by the failure of the timing markers to operate. In this case, only Rapatronic camera records were used for measurement, since their absolute times were known. Comparison was then made of diameters obtained from these records and diameters determined from the Ranger A burst, giving a yield ratio

$$\frac{\text{Yield TS-1}}{\text{Yield Ranger A}} = 1.01$$

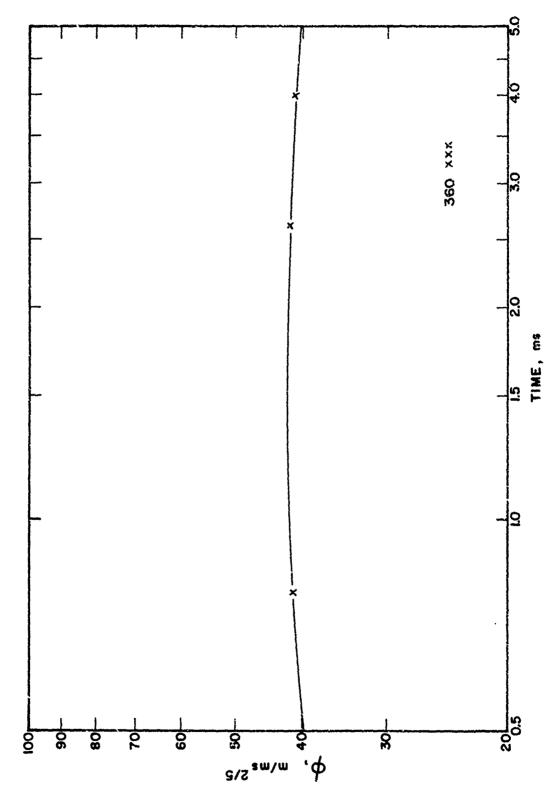
The same ratio determination was made for TS-2, using both Eastman and Rapatronic films for measurement. This method thus satisfactorily determines yield for small bombs, although reliability of the answer is only  $\pm 10$  per cent.

### 3.2 LOCATION OF CAMERAS

The phototrucks and phototrailers were prewired in Boston and positioned on concrete pads approximately 2 miles from Ground Zero. These areas were stabilized to reduce the interference rendered by dust. On all shots at least two photostations were operated, roughly 90° apart, affording two distinct views for observation of the fireball growth.

Maps showing these various layouts of camera stations are presented in Apperaix ?

(Text continues c.. page 35.)



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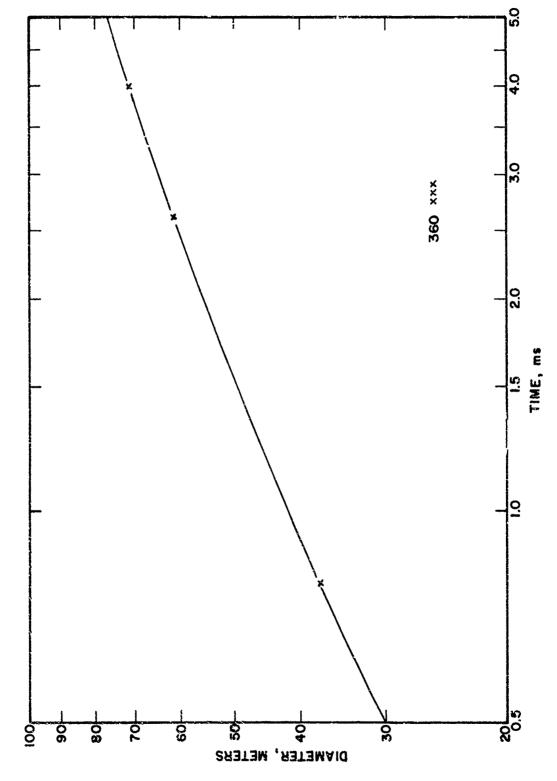


Fig. 3.2-TS-1 diameter vs time.

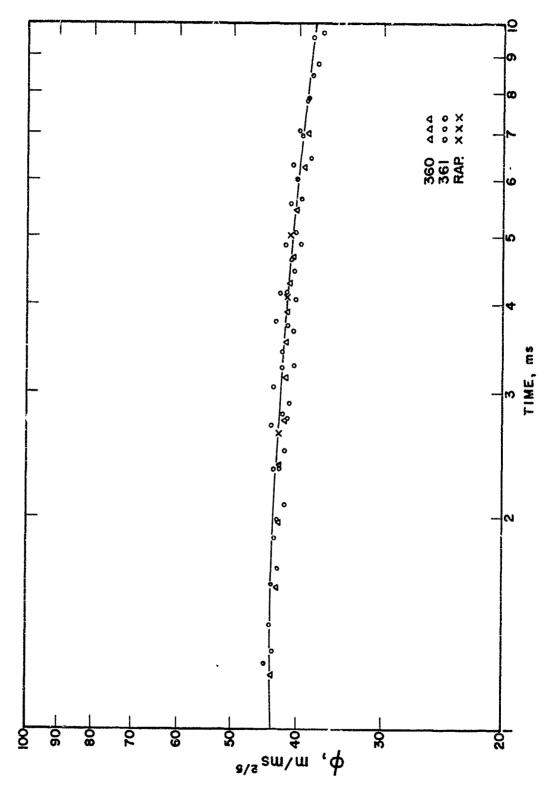
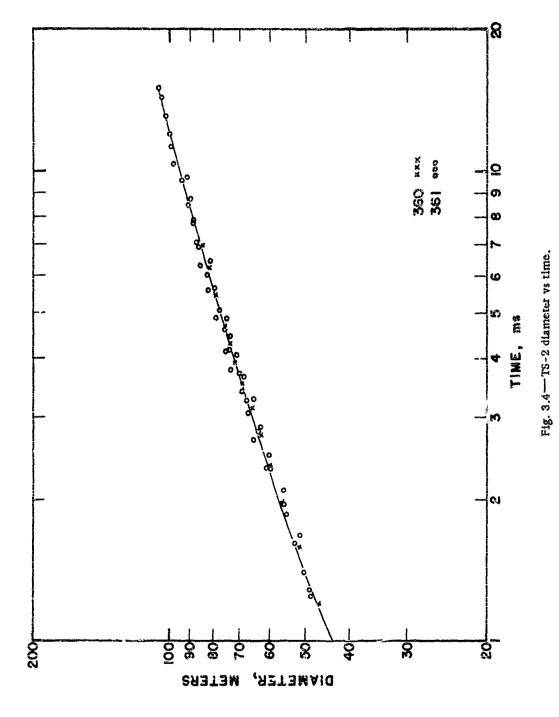


Fig. 3.3 --- TS-2 \phi vs time.



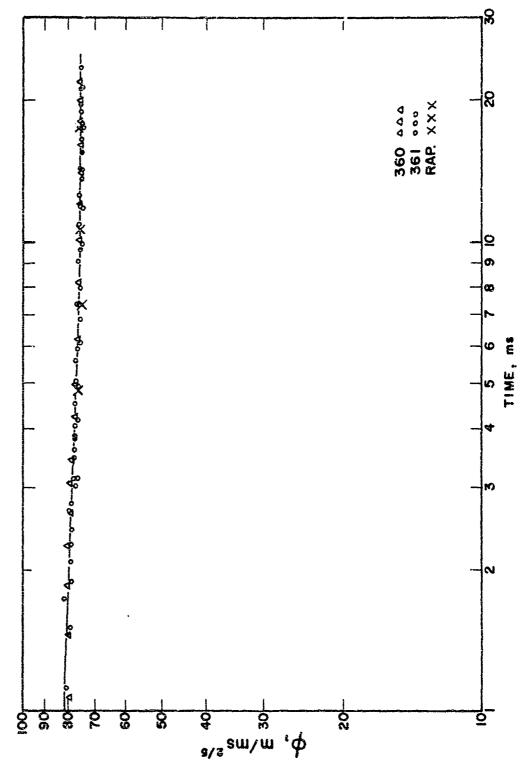
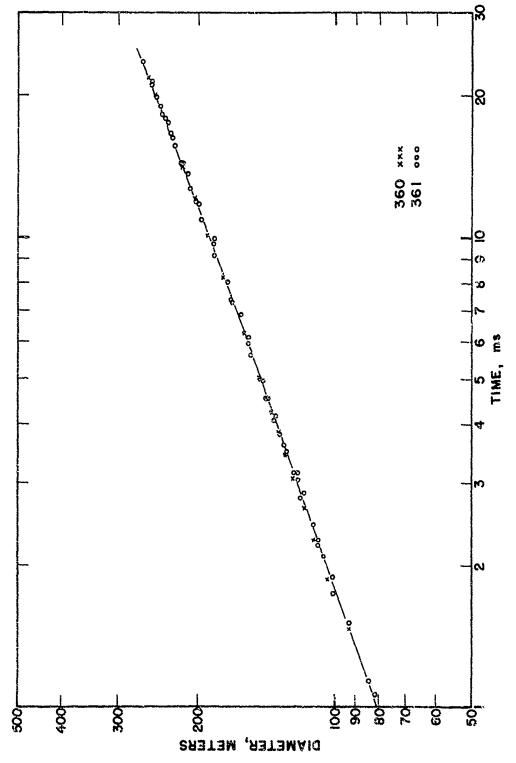


Fig. 3.5 - TS-3 & vs time.



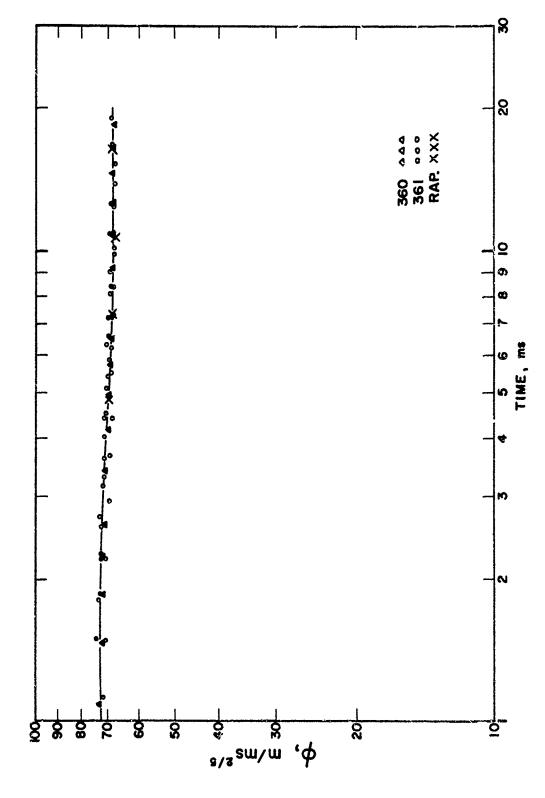
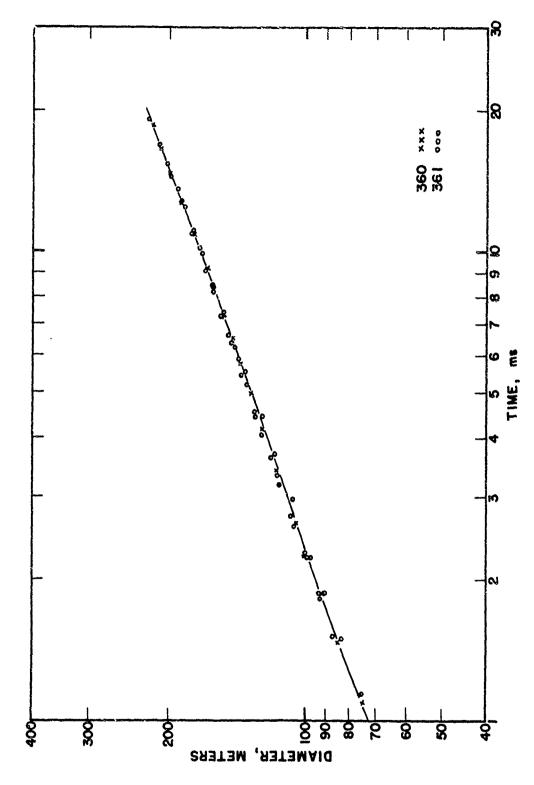
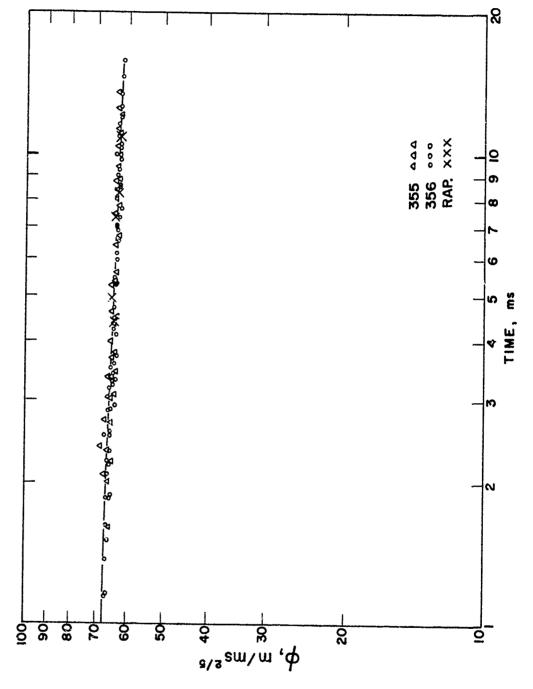


Fig. 3.7--TS-4 \phi vs time.





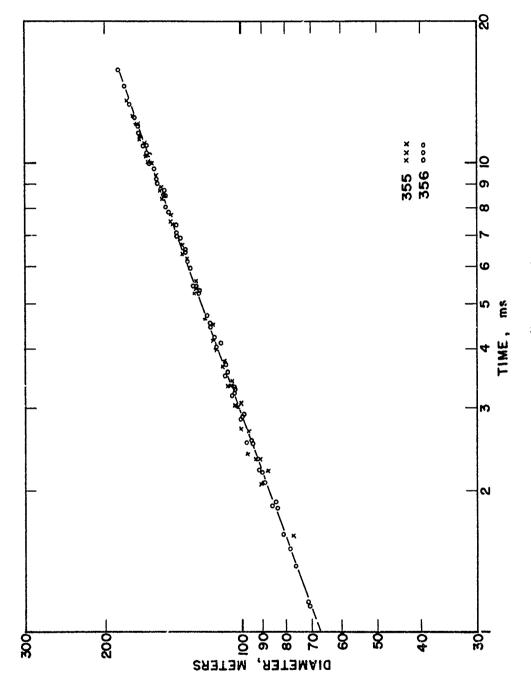
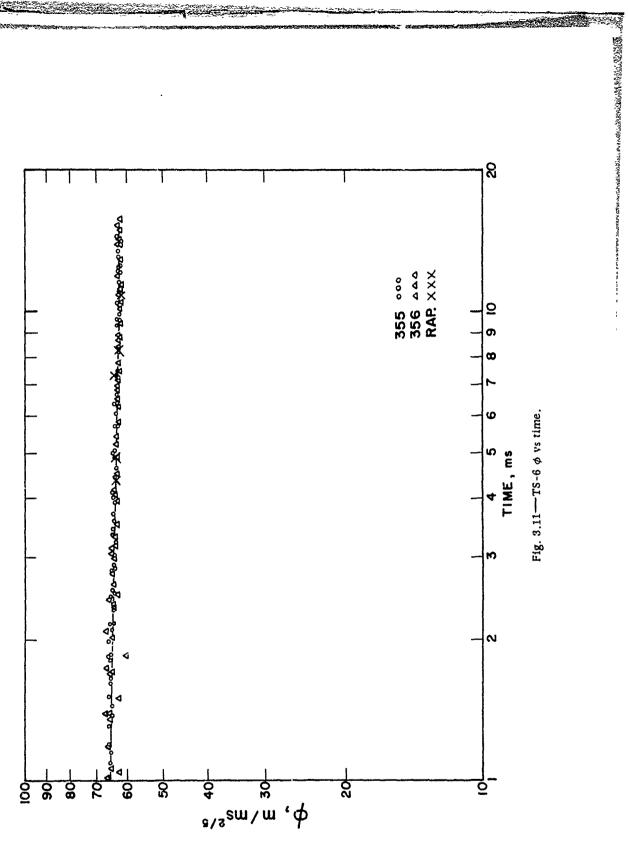
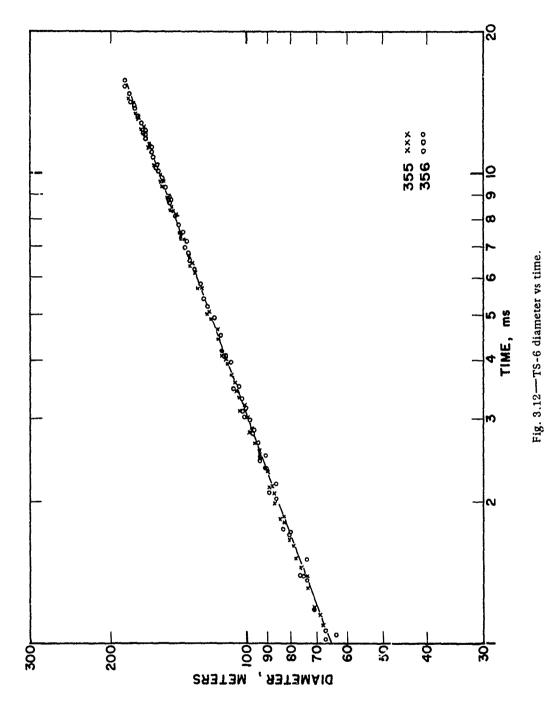
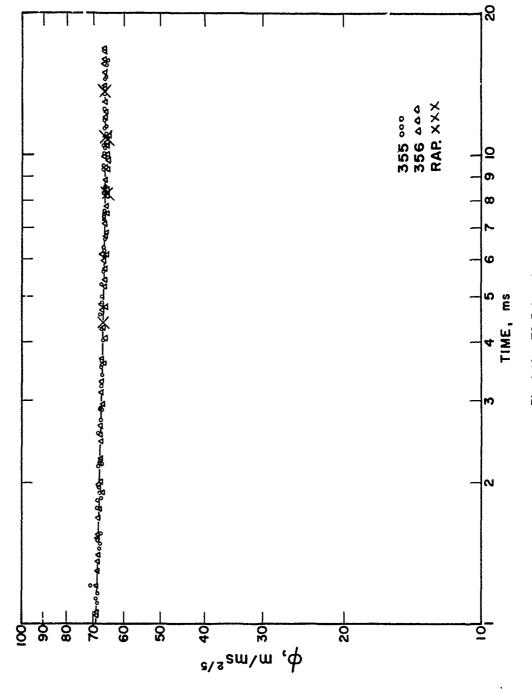


Fig. 3.10-TS-5 diameter vs time.







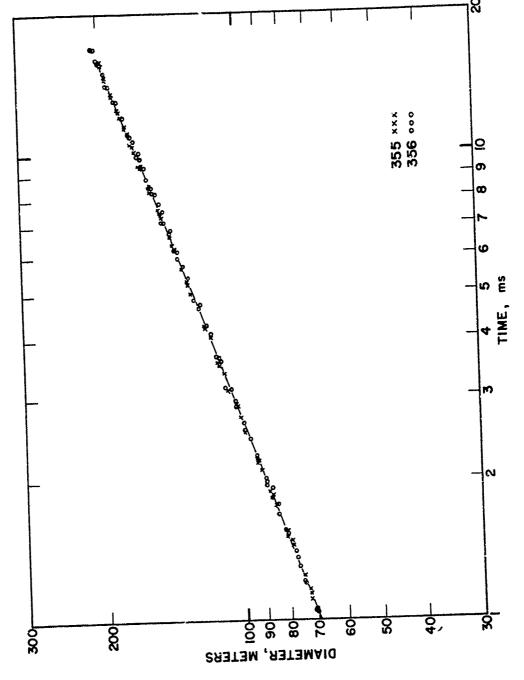


Fig. 3.14---TS-7 diameter vs time.

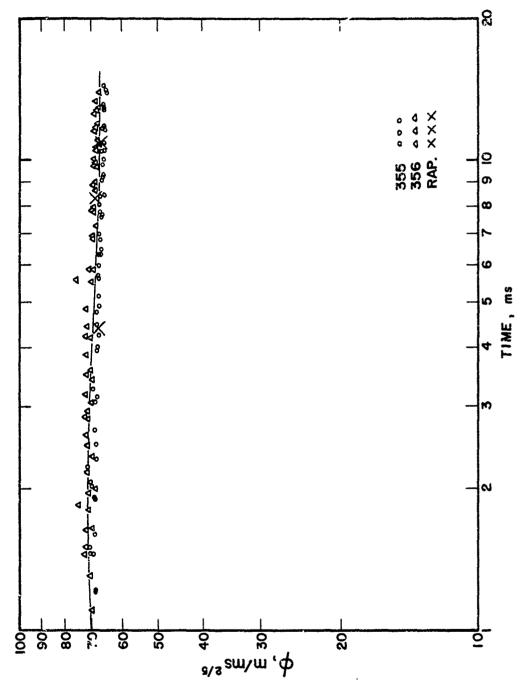
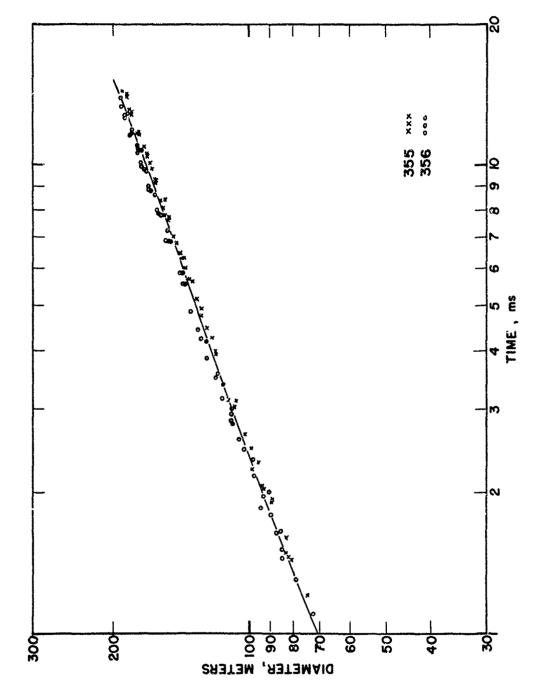


Fig. 3.15--TS-8 \$ vs time.

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φ' m/ms<sup>2/5</sup>



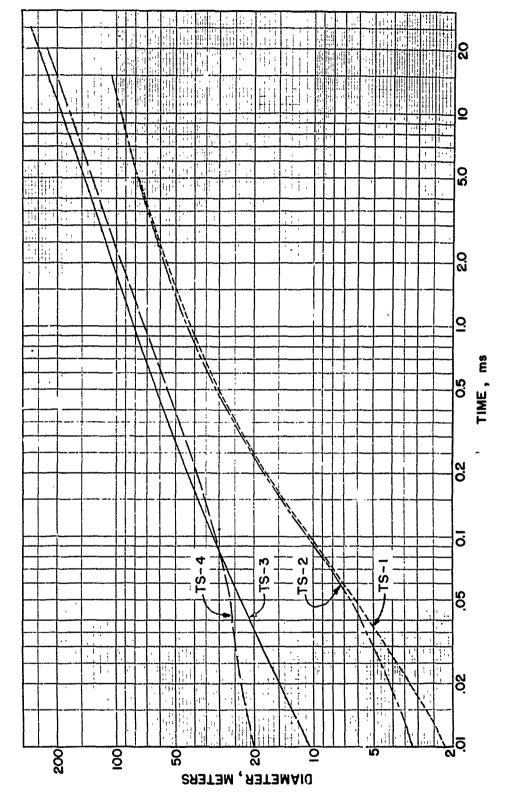
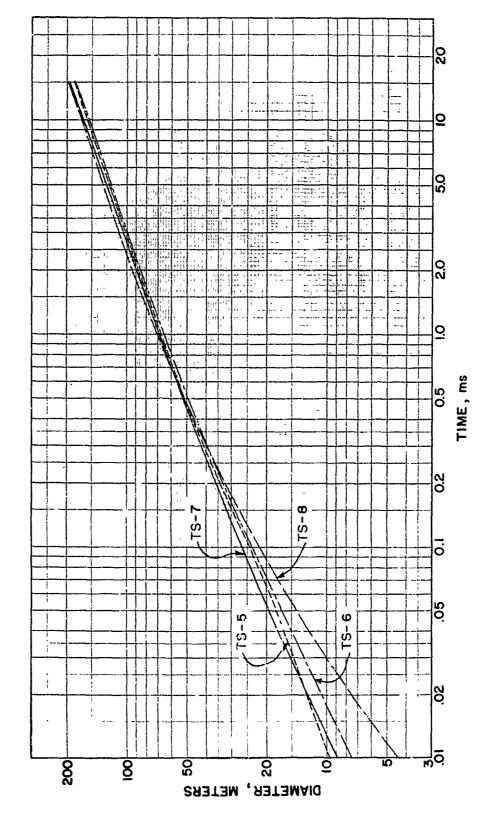


Fig. 3.18a-TS 1 to 4 dlameter vs time.



rig. 3,18b-TS 5 to 8 diameter vs time.

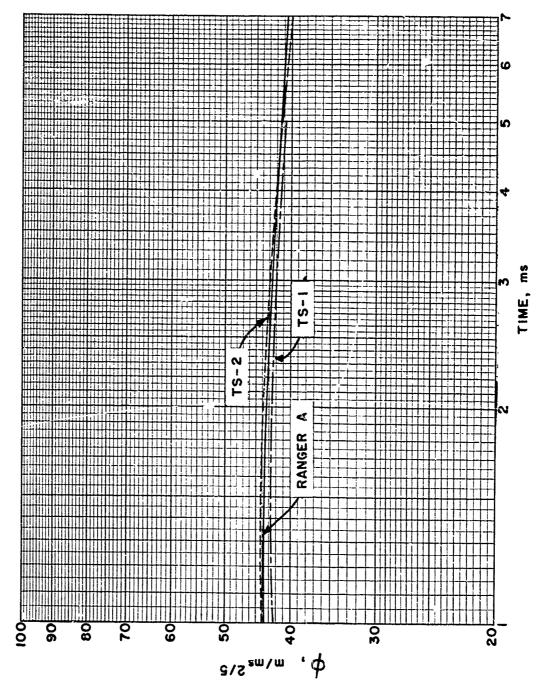


Fig. 3.19—Comparison of  $\phi$  vs time on Ranger A and TS 1 and 2 (Eastman data).

#### 3.3 PREPARATIONS

Before the operation, all cameras were collimated and the focal lengths were determined, as described in Appendix D. The films used for this purpose were exposed to constant temperature and relative-humidity conditions for several hours before being read. Likewise, all shot films were analyzed after being maintained under stable temperature and humidity conditions overnight.

### 3.4 EASTMAN PHOTOGRAPHY

The Eastman cameras were operated from the phototrucks as shown in Fig. 3.20. The films ran at between 2000 and 3000 frames/sec, the time scale being determined by a marker placing pips on the film at the rate of 200/sec. Use was also made of a fiducial mark placed on the film at zero time. A discussion of the methods of finding zero time and the time scale has been presented previously. Data from all Eastman films read are summarized in Tables 3.1 to 3.3. Detailed calculations for the individual films have been issued as EG&G Report 1093, Tumbler-Snapper Fireball Data, EG&G-OUT 1177, 4 September 1953.

## 3.5 RAPATRONIC PHOTOGRAPHY

In addition to the 16-mm high-speed Eastman camera records, the Rapatronic camera served as an invaluable aid in the determination of yields.

The magneto-optic shutter allows an exposure time of only a few microseconds at a preset time. This then provides a sharp image of the shock front and fireball edge at a precisely known time. As many as 16 such cameras were used on each test, and the points obtained were weighted in with the points established by the Eastman records. These are plotted in Figs. 3.1 to 3.18, the Rapatronic points being plotted with X's. A summary of data from Rapatronic records is also presented in Table 3.4.

Not only were these points valuable as a check on the Eastman films but they also provided a much more accurate measure of diameters at early times, since the time resolution for an Eastman frame is of the order of 70  $\mu$ sec and the Rapatronic 4  $\mu$ sec and 40  $\mu$ sec, depending on the shutter used. The 480-mm focal length allows a much larger image to be obtained, a distinct advantage at the early times. These large images at an early time also supply a means of determining the time of the "zero" frames on the Eastman records.

# 3.5.1 Eastman Zero-frame Time Determination from Rapatronics

From these early Rapatronic plates, time of the "zero" frame (i.e., the first exposed frame after detonation) on the Eastman films could be readily determined merely by a comparison of diameters. A graph of diameter vs time was drawn from the Rapatronic data. The first and second, and in some cases the third, Eastman frame diameters were measured. From the Rapatronic graph it was then easy to determine the respective times for these diameters. Since the velocity of the film was known, the zero-frame time could be obtained by subtracting from the time of each frame the corresponding time elapsed between it and the zero frame.

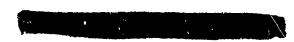
EXAMPLE: At times determined from Rapatronic diameter vs time graph.

Diameter at zero frame 25.5 meters at 0.125 msec
Diameter at 1 frame 46.2 meters at 0.435 msec
Diameter at 2 frames 57.7 meters at 0.720 msec

Subtracting elapsed time:

Frame 0 0.125 msec -0.0 msec = 0.125 msec

Frame 1 0.435 msec-1 (frame)  $\times$  0.3203 msec = 0.115 msec Frame 2 0.720 msec-2 (frames)  $\times$  0.3203 msec = 0.080 msec



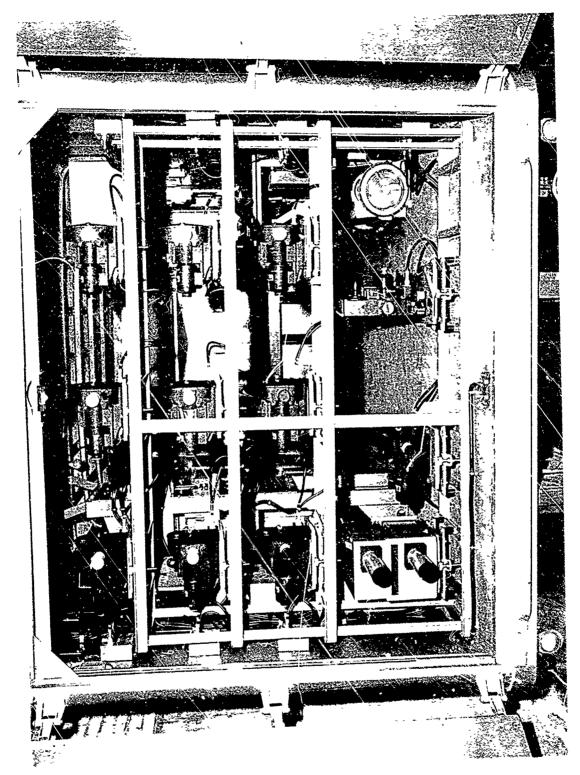


Fig. 3.20—EG&G phototruck —camera racks.

Table 3.1 -- SUMMARY OF EASTMAN DATA FOR FIREBALL

			Total No.				
Shot	Film No.	Sta. No.	read	φ	η	o <sup>2</sup>	σ
TS-3	13201	7-360	19	75.49	9	0.1243	0.810
	13203	7-361	18	75.37	9	0.4272	0.654
	13205	7~361	16	75.25	9	0.2268	0,476
	13206	7-361	16	74.74	8	0.1442	0.380
TS-4	13301	7-360	19	68.63	11	0.4414	0.664
	13303	7-361	15	89.79	7	1.9274	1.388
	13305	?-361	16	69.26	11	0.6877	0.829
	13306	7-361	19	68.27	11	0.3874	0.622
TS-5	13400	1-355	13	63.09	9	0.2479	0.498
	13401	1-355	14	63.66	В	0.2482	0.498
	13403	1-355	16	63.96	9	0.7655	0.375
	13404	1-356	15	63.19	7	0,5642	0.751
	13406	1-356	16	63,58	10	0,3330	0.577
	13407	1-356	15	62.96	15	0.4856	0.697
	13410	1-356	19	63.51	9	0.4195	0.648
TS-6	13600	4-356	21	62.30	12	0.1309	0.362
	13601	4-356	17	62.49	11	0.3135	0.560
	13602	4-356	19	62.59	8	0.5954	0.772
	13603	4-356	20	62.50	11	0.5604	0.749
	13605	4-355	16	63.13	11	0.3859	0.621
	13606	4-355	21	62.67	12	0.6072	0.779
	13607	4-355	18	62.93	10	0.3659	0.605
	13610	4-355	18	63.35	8	0.2588	0.509
TS-7	13700	3-355	18	66.24	10	0.0701	0.265
	13701	3-355	16	66.48	7	0.0231	0.152
	13702	3-355	20	€6.13	9	0.1989	0.446
	13703	3-355	19	66.23	8	0.0745	0.273
	13705	3-356	16	66.19	9	0.0403	0.201
	13706	3-356	20	66.00	12	0.1476	0.384
	13707	3-356	18	65.93	8	0.0364	0.191
	13710	3-356	20	65.58	8	0.0669	0.259
TS-8	13800	2-356	16	68.82	8	0.2139	0.462
	13801	2-356	15	69,15	7	0.8615	0.928
	13802	2-356	15	67.81	8	0.5372	0.733
	13803	2-356	17	68.72	8	0.3453	0.588
	13805	2-355	12	66.21	8	C 2995	0.173
	13806	2-355	16	65.91	10	0.6756	0.822
	13807	2-355	13	66,20	7	1.0848	1.042
	13810	2-355	18	66.93	9	0.3923	0.198

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The average of these times was then considered the best value for the time that the zero frame was exposed.

0.125 msec

0.115 msec

0.080 msec

0.320 msec or an average of 0.107 msec

Table 3.2—DIAMETER VS TIME DATA

	t <sup>-2/5</sup>				Diamete	r, meters	5		
Time	(msec <sup>-2/5</sup> )	TS-1	TS-2	TS-3	TS-4	TS-5	<b>TS-</b> 6	TS-7	TS-8
10 μsec	6.310	2,2	3,2	10.5	20.0	9.7	7.5	8.9	4.4
20 μsec	4.782	3.3	4.2	14.8	23.4	12,7	10.5	12.6	7.5
50 μsec	3.314	6.2	6.5	23,4	26.4	17.9	16.6	19.4	14.1
100 μsec	2.512	10.4	10.7	32.2	31.4	24.2	23.7	26.6	21.7
200 μsec	1.904	17.4	17.9	43.2	39.0	34.1	33,1	35.9	32.1
500 μsec	1.320	30.2	31.2	62.2	54.6	50.9	49.3	52.7	51.1
1 msec	1.000	41.9	43.6	81.2	72,5	67.2	65.3	69.3	70.3
2 msec	0.7579	55.4	57.4	104.6	95.5	87.6	85.5	89.7	94.0
5 msec	0.5253	76.7	77.1	145.4	132,3	123.0	120.5	126.6	131.4
10 msec	0.3981		94.9	189.1	170.8	158.2	155.7	166.1	168.3
15 msec	0.3385		105,8	222.5	200.9	183,2	183.2	195,3	197.9
20 msec	0.3017			249.6	225.4				
25 msec	0.2760			272.9					

Table 3.3 —  $\phi$  VS TIME DATA

			(	þ, meters	s/msec <sup>2/5</sup>	<b>i</b>		
T:me	TS-1	TS-2	TS-3	TS-4	TS-5	TS-6	TS-7	TS-8
10 μsec	13.6	19.9	66.3	126.4	61.0	47.5	56.3	28
20 μsec	15.7	20.2	70.8	112.0	60.8	50.0	60.2	36
50 μsec	20.6	21.7	77.7	87.5	59.3	55.0	64.3	46.7
100 μsec	26.2	27.0	80.8	78.8	60.7	59.5	66.7	54.4
200 μsec	33.2	34.1	82.2	74.3	64.9	63.0	68.4	61.2
500 µsec	39.9	41.2	82.1	72.1	67.2	65.1	69.5	67.4
1 msec	41.9	43.6	81.2	72.5	67.2	65.3	69.3	70.3
2 msec	42.0	43.5	79.3	72.4	66.4	64.8	68.0	71.3
5 msec	40.3	40.8	76.4	69.5	64.6	63.3	66.5	69.0
10 msec		37.8	75.3	68.0	63.0	62.0	66.12	67.0
15 msec		35.8	75.3	68.0	62.0	62.0	66.12	67.0
20 msec			75.3	68.0				
25 msec			75.3					

# 3.5.2 Collimation

Focal lengths of the Rapatronic cameras were measured in the field using the collimator pictured in Fig. 3.21. This collimator was braced on a stand on the ground at the rear of the vehicle containing the camera rack.

The collimator contains the target, which is a series of fine wires placed obliquely to the collimator focal plane. The middle wire is in the focal plane. The wires are then photographed by the Rapatronic, the wire in sharpest focus showing the point of infinity focus for the Rapatronic. The wires have been arranged so that each one represents a change of 0.01 in. in the Rapatronic focal length. By inspecting the photograph, the amount of adjustment necessary to bring the Rapatronic into best focus for infinity is easily determined. Positioning the focal plane to an adjustment of 0.01 in. results in very sharp pictures.

Table 3.4—SUMMARY OF RAPATRONIC RECORD DATA

					NA	ME			DATE		JOB NO
					Fit	,rers					
FILM #	CAMERA -F	COITATE	Time (us)	EMULA 10N			Ecr. Aper.	ф	Diam (m)	Rema	rks
TS-1					П						
13041	5-9	F-361	100	MF	Ī-	_	150	26.1	10+		
42	R- 33	4	403	,	_		150	39.1	27.2		
43	R-19	F-362	50	•	-	-	150	20.2	61		
44	R-18	"	212	"	<u> </u>		۱۶۵	33.9	18.2		
45	R-26	F-361	11	HRHS	Ţ <u>-</u>		150	13.4	2,2		
46	R-31	11	32	,	-		150	17.4	4.4		
<del>ላ</del> ገ	R-24	F-362	2632	•	-	-	150	41.7	61.4		
48	R-4		18	٠	-	_	150	16.1	3.2		
49	R- e	F-361	30	Ekta	-	CC401	10			Calor-Ove	exposed
50	R-6	11	So	11	-	ردبه M	70			11	•
કા	R-12	F-362	36	ECP	-	-	76			" - no b	alance
52.	R-17	w	80	11	-	_	70			" "	"
<b>5</b> 3	6-8	F-361	5040	Tri X	-		150	40.3	17.0		
54	R-10	٠	4000	"	-		150	41.1	71.6	*	
ss	R-14	F-362	3000	"	-		150		-		
56	R-29	.,	18.0	HRHS	E		150	41.2	37.3		
			ļ		<u> </u>				<u> </u>	<b> </b>	
TS.5					┢				<del> </del>	<b> </b>	
13141	R-9	7-361	103	MF	-		150	27.1	10.9	<u> </u>	<b> </b>
42	R-33	•	411	•	-	-	150	39.95	28 0		
43	R-19	1-362	50	•	-	-	150	20.63	6.2		
44	R-18	,,	205		-	_	150	34.30	5.81		
45	R-26	7-361	12	HRHS	-	-	150	20.73	3.5		
46	R-31	"	32	"	_		150	21.43	5.4		
77	R-24	7-362	کا مئے	•	_	_	150	42.57	192.5		
48	R-4	,	18	v	-	_	150	19.45	4.0		
५१	2.5	7-361	7495	Ekte	ļ.		70				
50	R-6	r	53	ECP	0.5	858	220				
SI	R-12	7-362	40	'1	٥	8 s B	२०				
52	R-17	•	84	ti	0.5				T	]	T T
53	R-8	7-361	೯೦೭ಽ	Tri X	<u> </u>		150	41.16	78.5	T	1.
54	R-10	,	4075	1,11	<u> </u>	_	150	41.45	72.8		
SS	R-14	7-362	2990		Ŀ		150			*	
56	R-29	٧.	773	HRHS	-	-	150	42.93	38.7		
									T		
					Т						1
* Fired a	arty and	محدثا معما	due to	an unchi	614	nt ha	nstormer.		<b>1</b>		

Table 3.4—(Continued)

					NA	ME			DATE		JOS NO
- 12 T. 12 T. T. 14 T.						TERS					
fi um 🚁	CAMERA #	STATION	TIME (VS)	Emuceion	<del></del> -		EFF. APER.	Φ	DIAM (M)	Rema	KKS
TS-3											
13241	R-9	7-361	100	MF	-		150	81,20	32,3		
42	R-33	"	403	<u> </u>	-		150	82.25	57.2		
43	R-19	7-362	49	<u> </u>	<del>                                     </del>		150	- 00.05	<del>-   -</del>	Blank	
44	R-18	"	4860	TriX	1		150	76.40	143.8		
45	R-26	7-361	10	HRHS	-		150	66.14	10.4	<del> </del>	
		1-301	30	4542	+		150	71.86	<del>                                     </del>		
<u>40</u>	R-31	7-362	7336	- 11	1=		150	75.75	168.1	<del>   </del>	
48	<del></del>	<del></del>		<del></del>	-			72.62	14.2	<del> </del>	
	R-4	1 24	17	€.CP	+-		150	12162	14.2		
49	R-5	7-361	134	<del> </del>	-	CCIOM	70	<b></b>	<del> </del>	Color	
<u> </u>	R-C		31,675	Ekta.	<u> -</u>	CC40M	<del></del> -	<b></b>	<del> </del>	Color	
SI	R-12	7-362	215	ECY	ļ-	CCIOM	70	<del> </del>	<del> </del> -	Gler	
52	R-17	"	80		├-	CC 10 M	76	<del> </del>	<del> </del>	Color	
53	R-8	7-361	20,130	Try	二		150	<del>                                     </del>	<del> </del>	Fogged-werps	andra or
54	R-10		17,455	<u> </u>	1-		150	75.94	238.4	ļ	
55	R-14	7-362	10,756		-		IS0	75.54	195.4	ļ	
56	R-29		785	HEHS	-		150	81.19	73.7	ļ	
	ļ				↓_				<b></b>		
TS-4	<u> </u>		<u> </u>		↓_			<del> </del>	<del> </del>	<del> </del>	
13341	R-9	7-361	100	MF	<u> -</u>		150	78.6	31.3	ļ	
42	R-33	<u> </u>	403	- 11	ᆣ		150	72.4	50.3	<u> </u>	
43	R-19	7-362	49		Ŀ		150	87,3	26.2	<del> </del>	
44	R-18	,	4800	Tri X	<u> -</u>		150	69.4	130.7	<u> </u>	
પ્ડ	R.26	7-34	10	HRHS	<u> -</u>		150	126.2	20.0	<u> </u>	
46	R-31	•	30	''	<u> </u>		150	99.9	24.6	<u> </u>	<u> </u>
41	R-24	7-362	7335	"	<u> </u>		150	68.2	151.4		
48	R-4	"	17	"	<u> </u> -		150	115.8	22.7		L
49	R-5	7-361	25,650	Ekta	-	CC 40M	70			tions sin	pleakage
50	R-6	*	155	ECP		CCIOM	70			Color	a
51	R-12	7-362	215		<u>_</u>	CE-10M	70			Color	
SZ.	R-17		80	•	<b> </b> -	26+ Mora	70			Color	
53	R-8	7-361	20,130	Trix	1-		150		I	NG	
SY	R-10	"	17,455	"	1_		150	68.6	215.5		
55	R-14	1-362	10,756		T-		150	47.8	175.4	T	
56	R-29	Υ.	185	HRUS	T_	_	150	1.55	65.4		
	1			1					1	1	
	1	<b> </b>	1		$\top$						
	1	<del>                                     </del>	<u> </u>		$\top$					1	
	+	<del> </del>	<del> </del>	<del> </del>	+		<del>                                     </del>	<del>                                     </del>	<del> </del>	+	1

Table 3.4—(Continued)

					NA	ME			DATE		1	JOB NO
						TER						
Firm +	CAMERA 4	STATION	Time (us)	Emuceion	+		Brf Aper.	ф	Dinm (m)	F	2€ma	eks
TS-S												
					<u> </u>						]	
13441	R-9	1-355	95	MF			150	60.23	23.5			
42	R-33	١,	403	1,	-		150	66.21	460	<u></u>		
43	R-19	1-356	49	ч	<u> -</u>		150	57,21	17.1			
44	R-18	*	210	u u	<u> </u>		150	67.15	36.0			
45	R-2L	1-355	10	HRHS	Ŀ.	_	150	60.86	٩.6			
46	R-31		28	<u> </u>			150	60.82	14.5			
47	R-24	1-356	7335	Tri X	<u> </u>		150	64.13	142.3			
48	R-4	•	4400	v	-		150	64.85	117.3			
49	R-5	1-355	16,800	Ekta	<u> -</u>	cc+oM	70			Color		
<u></u>	R-6	<u> </u>	152	ECP	<u> -</u>	BC+	70			Color		
SI	R-12	1-356	40	17	_		70			Color		
52_	R-17	v	82	٧	-	_	70			Color		
53	R-8	1-355	4946	TriX			150	<b>65.14</b>	123.4			
와	R-10	ч	8300	v	_		150	63.13	147.2			
55	R-14	1-356	10,900	"	Ţ-		150	62.45	162.9	weak	. exp	د ۱۳۵
54.	R-29	_ "	785	HRHS	-	-	150	66.57	60.4			
TS-6												
13641	R-9	4-356	95	MF	<u> </u>	~	150	60.3	23.5			
42	P-33		403				150	L3.0	43.8			
43	R-19	4-355	49		<u> </u>		150	50.4	15.1			
44	R-18	·	210	'	_		150	64.8	34.7			
45	R-26	4-356	10	HRHS	F	_	150	47.7	7.5			
46	R-31	,	28	••	_		150	543	12.9			
47	R-24	4-355	7335	11	-	_	150	64.0	142	<u> </u>		
48	R-4	"	4400	11	-		150	63.6	115			
49	TR-B	1	~0	ßХ	-	_	20					
50	TR-A	11	~0	Lin Pan	_		36					
53	R-8	4-356	4940	TnX	_	_	150	63.3	120			
S1L	R-10	11	8300	1/	_		150	42.2	145			
≤5	R-17	4.355	10,900	н	L		150	61.5	160	wea	ite.	
56	R-29	11	785	HRHS	<u> -</u>	_	150	673	61.1			
57	R-5	u	~0	Tr. X	<u> -</u>		70			NG)	Dork	slides
58	R-6	11	~0	Ł	_	-	70			NG	, not	pulled
59	R-1Z	u	~ 0	,	1-		70	l	T	NG		4
60	R-17	1.	~0	u	1-	_	70			NG	1	
			1		1					1	·,	

Table 3.4—(Continued)

					NA	ME			DATE		JOB NO
					FIL	TER.					
Film +	CAMERA #	STATION	Time (us)	EMULSION	ND	(,LOR	EFF APPR.	ф	DIAM (M)	Rema	ers
TS-1											
13741	R-9	3-355	95	MF	+-		150	664	25.9		
42	R-33	"	445	- "	1_		150	693	49.2		
43	R-19	3-356	49	,	1-		150	4.62	15.1		
44	R-18		210	"	_	_	150	P8 0	36.4		
45	2-26	3.355	10	HRHS	1_		150				
५८	R-31	,,	28	"	1-		150	61.9	14.7		1
47	R-24	3-356	7335	TriX	1-	_	150			NG- Trans	founer
48	8-4	"	4400		7-		150	66.85	120.9		
49	TR-B	"	20	ΒX	_		20				
50	TR-A	۳	~0	Lin Pan	T-	_	10				
<b>5</b> 3	R-8	3.355	13,650	TriX	-	_	150	66.19	189.3		
54	R-10	۳	8300	1	1-		150	65.96	153.8		
55	R-14	3-356	10,900	"	=	_	150	6617	171.9		
56	R-29		785	HRHS	-	_	150	69.50	63.1		
57	R-5	7-248	~0	Tri X	T_	_	70				
S٣	R-6	ч	~0	"	-	_	70				
59	R-12	•	20	"	1-	ــــــــــــــــــــــــــــــــــــــ	70				
(60	R-17	٧.	~ 0	•	]_		10				
TS-8											
13841	R-9	2-356	95	MF	-	-	150	53.8	21.0		
42	R-33	u	E 6 4	11	-		150	66.1	46.0		
43	R-19	2-355	49	HRHS	]-		150	46.4	13.4		
44	R-18	ľ	210	ME	<u> </u>		150	61.4	32,9		
45	R-26	2-356	10	HRHS	<u> -</u>		150_	229	3.6		<u> </u>
46	R-31	"\	28	"	-		lso	400	9.5		
<b>५</b> ٦	R-24	2-355	1335	Trix	1-		150			NG - Tra	nsforme
48	R-4	и	4400				150	ন্ন	122.5		
49	TR-B	V	~0	BX	]-	7	20				
50	TR-A	,	~0	Liu Pan	_	_	10				
53	R-8	2.356	13,650	TriX	<u> </u>	-	150			NG-Tra	15 forme
54	R-10	٧	8300	"	E		150	68.7	160.1		
হ§	R-14	2-355	10,700	"	_		150	اء اها	173.1		
56	R-29	u	785	HRHS	_		150	69.5	63.1		
รา	R-12	4	20	Trix	_		50				
S8	R-6	11	20		<u> </u>		50				1
S9	R-17	14	5,5	HRHS	1-		So			<u> </u>	<u></u>
60	R-5	"	3160	ECN	-		50		1		1

Delete

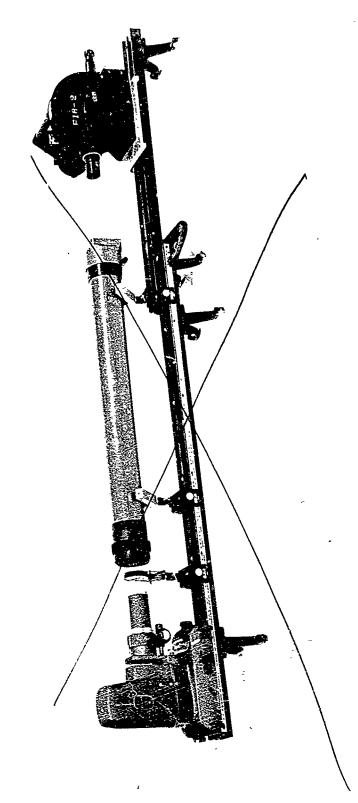


Fig. 3.21—Rapatronic collimator.

and the second s

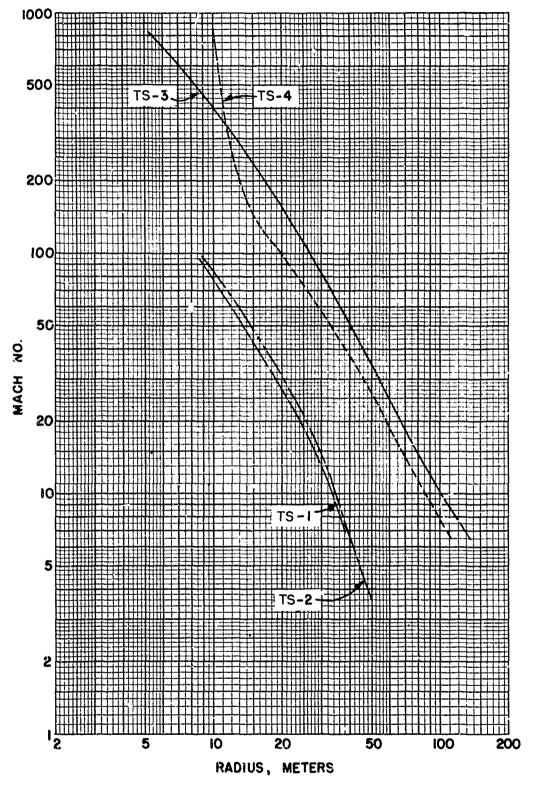


Fig. 3.22 Mach number vs radius, TS 1 to 4.

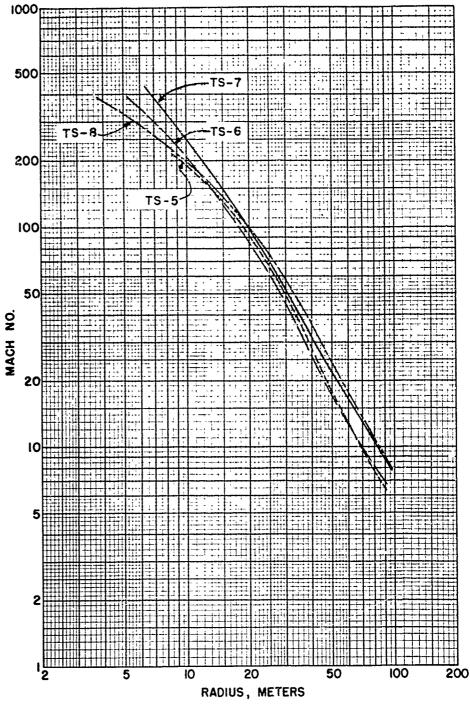


Fig. 3.22 — Mach number vs radius, TS 5 to 8. 3. 2.2

# 3.5.3 Time of Exposure

The exact time desired for the Rapatronic plate to be exposed can be set by means of a delay circuit connected to the camera. A Potter counter can then be used to calibrate this time interval between the zero-time signal and triggering of the camera shutter. A push button on the camera is connected to the input signal from the fiducial (which is actuated by bomb light). Thus a push on this button simulates zero time. The Potter counter indicates elapsed time from zero to the beginning of the exposure. The total delay is then the sum of the Potter counter reading and half the exposure duration of the film.

A pictorial report, Rapatronic Photography on Operation Tumber-Snapper, EG&G-OUT 1034, 29 December 1952, shows the views of each fireball from the two stations in time sequence.

## 3.6 MACH NUMBER AS A FUNCTION OF TIME

It is possible to calculate velocity of the shock front from the  $\phi$  and diameter vs time relations. From the equation

$$D = Kt^n$$

let

$$U = \frac{1}{2} \frac{dD}{dt} = \frac{1}{2} \frac{nD}{t}$$

where U = velocity of shock front

D = fireball diameter

t = time

n = time exponent

The Mach number is the ratio of the velocity of the shock front, U (which is coincident with the edge of the fireball before breakaway), and the velocity of sound,  $C_0$ , which varies according to the formula

$$C_0 = 331.5 + 0.607$$
T

where  $C_0$  is velocity in meters per second and T is temperature in °C. Values of  $C_0$  are tabulated for each shot in Appendix E. The Mach number is plotted as a function of fireball radius in Figs. 3.22 and 3.23:

3.21 3.22

## REFERENCES

- Richard A. Houghten, Analysis of Fireball Growth at Ranger, Ranger Report, Vol. 3, WT-203.
- 2. Ball-of-fire Observations, Greenhouse Report, Annex 1.4, WT-101.
- 3. Technical Photography, Buster-Jangle Project 10.3 Report, WT-417, December 1952.

## **CHAPTER 4**

# **TELETRONIC CAMERA**

In order to study the appearance of a detonation at approximately zero time, it is necessary to obtain a small field of view from a considerable distance and to have an exposure duration of the order of 1  $\mu$ sec. This was attained by a teletronic camera on Greenhouse. The same camera with minor adjustments was used on Buster-Jangle. These cameras are similar in operation to the Rapatronic.

Two such cameras were employed on the last three shots of Tumbler-Snapper. One utilized a Cassegrainian telescope and the other a Newtonian telescope to produce a good size image of only the region near the cab.

Preshot photos of the zero tower for TS-8 taken with the Newtonian type and with the Cassegrainian type telescopes are shown in Figs. 4.1 and 4.2, respectively. Figures 4.3 and 4.4 are photographs taken of the TS-8 zero tower at approximately zero time with the Newtonian type and the Cassegrainian type, respectively.

# REFERENCE

1. Ball-of-fire Observations, Appendix C, Greenhouse Report, Annex 1.4, WT-101.



Fig. 4.1—Preshot photograph of TS-8 tower, New, mian type camera.

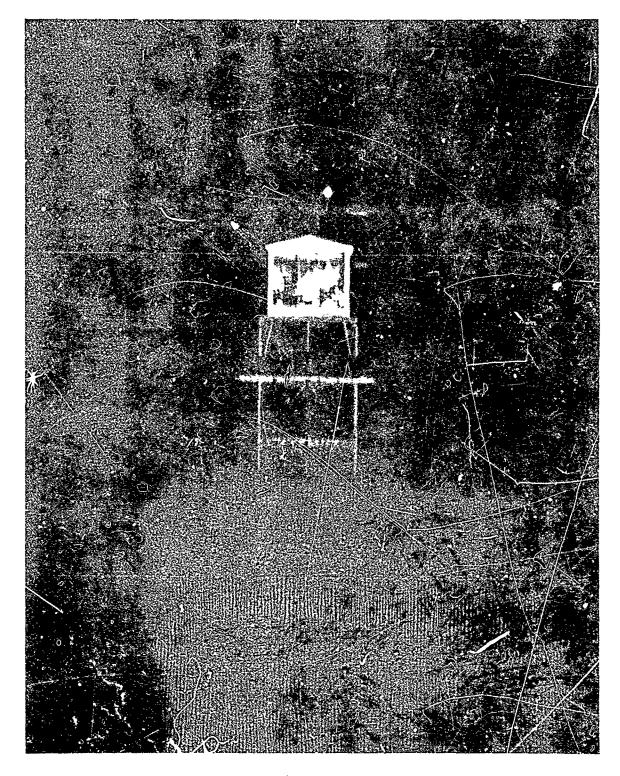


Fig. 4.2—Preshot photograph of TS-8 tower, Cassegrainian type camera.



Fig. 4.3—Approximately zero time photograph of TS-8 tower, Newtonian type camera.

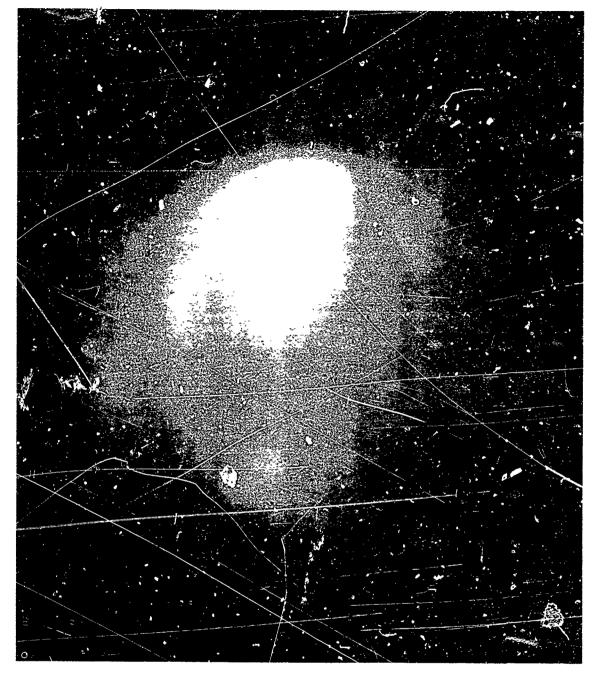


Fig. 4.4—Approximately zero time photograph of TS-8 tower, Cassegrainian type camera.

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### CHAPTER 5

# POSITION OF BURST

Position-of-burst determination was required for the four airdrops (TS 1 to 4) of the Tumbler-Snapper series. Two Wild phototheodolite cameras and two modified K-17 cameras were used for each shot, one camera of each type being set up at two of the standard photostations on a concrete platform adjacent to the truck or trailer.

Shadow images of battery-operated fiducial markers were placed on the film in an exposure made the day before the shot, and the fireball image was superimposed in a second exposure. A typical example taken with a Wild phototheodolite is shown in Fig. 5.1. Each camera was triggered by the closing of a relay by means of a signal from a photocell (Blue Box) at zero time. The phototheodolite exposure time was set at  $\frac{1}{200}$  sec and the K-17 at  $\frac{1}{150}$  sec. Thus exposures were made during the time when the edges of the fireball were still sharp and clear, and the exact center of the fireball, which was assumed to be the initial burst position, could be accurately determined. Coordinates of the burst were found by triangulation from the two photostations.

Two Mitchell camera records intended primarily for data on rockets were used to determine burst position for TS-1, because the theodolite solenoid pulsers failed to operate. Silvered glass globes at known distances in . • field of view of the cameras were used as reference markers in this case.

All survey cameras operated satisfactorily for the other three airdrops. A summary of burst positions and aiming errors is presented in Table 5.1.

Inasmuch as TS 5 to 8 were tower shots, it was not necessary to use the theodolite cameras for determination of burst.

Table 5.1 - POSITION-OF-BURST DATA SUMMARY

		Coor	d. of detor	nation, ft		Air	Aiming error, ft						
Shot	Area	N	E	Z (burst ht.)	ΔΝ	ΔΕ	Circular error	ΔZ					
TS-1	F	746372	714067	793	122	67	140 ± 20	-7 ± 10					
TS-2	7	850281	688769	1109	-143	84	$165 \pm 20$	+9 ± 10					
TS-3	7	850344	688561	3447	-80	-124	148 ± 20	$-3 \pm 10$					
TS-4	7	850284	688532	1040	-140	-153	$205 \pm 20$	$-10 \pm 10$					

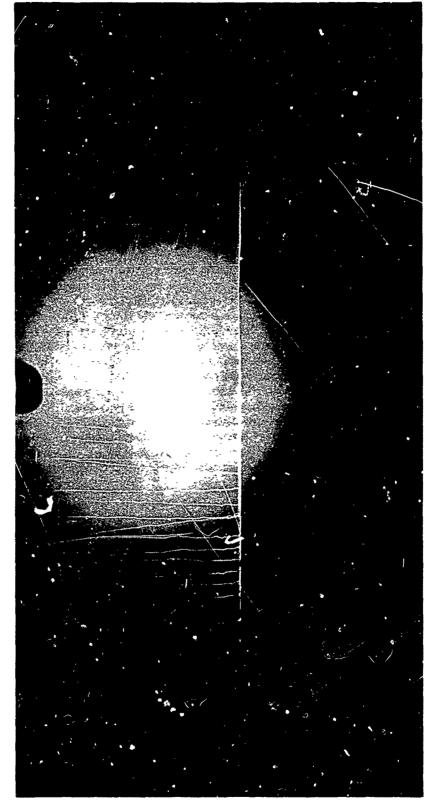


Fig. 5.1-- Typical photograph of burst taken with the Wild phototheodolite.

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CHAPTER 6

# **BLAST STUDIES**

EG&G was asked to supply certain information which would aid in the various studies of blast. On the airdrops this was accomplished by photography of mortar puffs, Jato plumes, and rocket trails, and on the tower shots by gun puffs and shock studies.

In most instances the services of EG&G were those of obtaining the photographic record and developing and processing of films. These films, with the necessary data for interpretation, were transferred to the various groups concerned for their own analysis. The only exception to this procedure was the measurement of motion of the mortar puffs by EG&G personnel. These measurements were made at the request of J-Division, Los Alamos Scientific Laboratory (LASL), and were turned over to them without further analysis. This report will concern itself with the plan by which EG&G obtained the desired pictures.

To show individually all of the camera-station layouts for each study for all shots would prove too lengthy. Therefore the separate layouts for each study, such as rockets, mortars, etc., have been broken down for TS-1 only and are shown in Appendix C. Layouts for TS 2 to 4 have been combined in three master maps and also appear in Appendix C.

## 6.1 AIR-MASS MOTION

In order to study the effect of blast on free air, a new technique was devised. Particles of smoke from inverted Jato columns and from mortar-shell smoke puffs were considered to behave in the same manner as particles of air, and the actual motion of a smoke particle was used for measurement.

The "Jatos" were smoke generators located along a line 500 ft from the blast line and parallel to it. These were timed so as to set up a column of smoke before arrival of the shock wave. The mortar puffs were essentially a type of commercial fireworks, sometimes known as aerial salutes, the only change being that the yellowish smoke burst was replaced by a white smoke for better visibility. The inverted Jatos, reaching a height of about 200 ft, showed the trajectory of the triple point, and illustrated, in a general way, the shape of the shock front as it passed by and deflected them. By measuring the motion of the mortar puffs, 200 to 300 ft above ground, the velocity of the shock wave and, hence, overpressure can be calculated.

A series of 10 mortar-Jato stations was set up for each the four airdrops. Six Eastman cameras and three Mitchells were located at two of the normal photostations as indicated in Fig. 6.1. Cameras were aimed so that each camera would view one or two of the Jato stations, several of the stations being viewed by two cameras with overlapping fields of view.

Preliminary measurements of mortar-puff motion were made from the Eastman films, but EG&G made no attempt to analyze the results in Boston other than to plot displacement vs time in two dimensions only. These measurements were sent to J-Division, LASI, who were to conduct any further analysis.

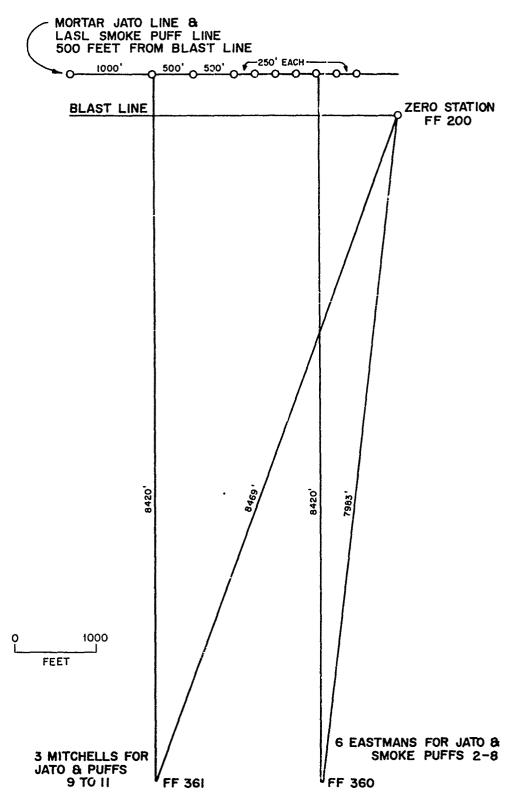


Fig. 6.1—Camera layout for TS-1 blast.

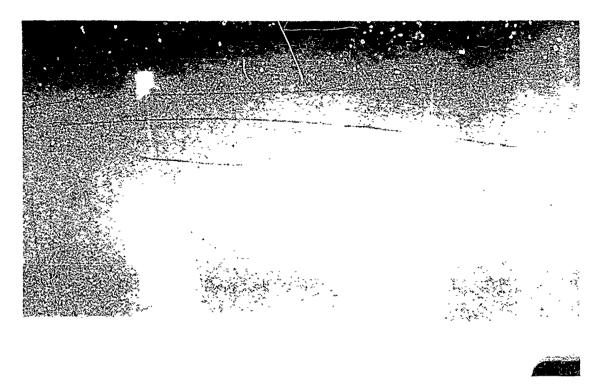


Fig. 6.2—Eastman photograph of shock wave crossing field of view of camera. Note position of triple point.

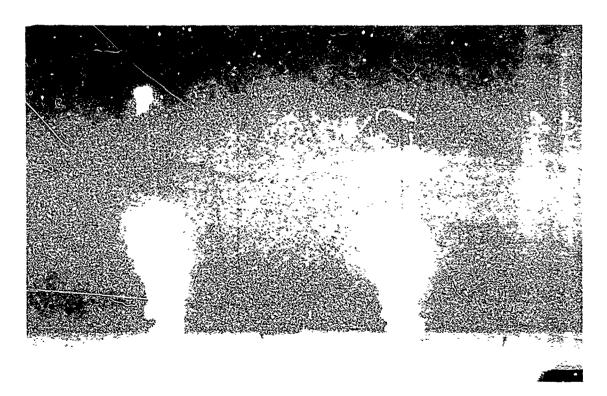


Fig. 6.3—Eastman photograph of shock wave crossing field of view of camera. 40 frames after Fig. 6.2.

Right plume has shifted, and triple point has moved to a position between the two plumes.

Rocket trails were also used on the airdrop for the determination of particle velocity and as backup for the mortar-Jato stations. Here again a particle of smoke was assumed to behave identically with a particle of air. This was the first time rocket trails had been used for this purpose.

For two tower shots, TS 5 and 8, gun puffs of black smoke were photographed by three Mitchell cameras to record mass motion of the air. These records were not as successful as the white-smoke photographs, since all films were underexposed and showed weak positive motion only. Gun puffs were not used on TS 6 and 7.

Since no rocket trails were employed on the tour tower shots, an attempt was made to photograph the visible shock wave leaving the fireball and also the formation of the stem and dust skirt. For this purpose, three Eastman cameras using microfile film were employed. Several of the films showed the shock wave clearly as it passed across the field of view of the camera. Figures 6.2 and 6.3 are excellent examples of the results of this technique. In these photographs, taken from a 16-mm Eastman record on the first shot, both the incident and reflected shock waves are clearly visible, first approaching one Jato and then, 40 frames later, between the two Jato plumes. The motion of the Jato which has been passed by the shock wave is evident from a comparison of the two pictures.

#### 6.2 SHOCK-WAVE PROPAGATION

In order to study the velocity of the shock front on the four airdrops of Tumbler-Snapper, rocket trails were located perpendicular to the line of sight of the cameras, and the shock wave was photographed as it passed in front of these trails. The progress of the shock wave was then followed by observing the "hooks" in the rocket trails at the shock front. These hooks are due to the change in the index of refraction of the air at the shock front. This same system had previously been employed on Greenhouse.

The rockets were fired at 85° angles radially away from their respective photostations in order that the trails would appear as straight lines on the film.

High-speed Mitchell cameras, running at 100 frames/sec, obtained the film records which were then sent to the Naval Ordnance Laboratory for analysis.

The physical layout of the cameras with respect to the blast line and rocket trails is shown in Fig. 6.1.

#### CHAPTER 7

# ADDITIONAL PHOTOGRAPHY

#### 7.1 THERMAL EFFECTS

This program was initiated by AFSWP to provide supplementary data to the general blast-measurement program. The study was to indicate the presence of "thermal dust" and "temperature gradients" near the ground. These dust, preshock-turbulence, light-absorption, and mirage effects were recorded with A-5 cameras running at approximately 35 frames/sec, located 200 ft off the blast line (see Fig. 7.1). These stations consisted of concrete cubicles 18 in. from the ground, into each of which a rack containing two cameras was inserted from the top. The access hole was then sealed with a lead block, and the pictures were taken through a glass window located on one side of the station.

Smoke generators were started prior to zero time, and the smoke pattern was photographed to show the behavior of prezuro laminar and turbulent air flow.

Spotlights hung in the field of view at  $1\frac{1}{2}$ , 3, 6, and 12 ft from the ground were used to determine the amount of light absorption and air turbulence.

Temperature gradients were observed by noting air turbulence and the total reflection or refraction such as that associated with mirage conditions.

These pictures also provided a study of the thermal dust created before shock arrival from the intense heat which literally causes the ground to explode. All such films were turned over to AFSWP for analysis.

## 7.2 CLOUD STUDIES

During Tumbler-Snapper the cloud formations associated with the various shots were photographed from various angles with cameras running at a variety of speeds for the purpose of studying cloud drift and rate of rise.

The cloud-rise program was designed to record the dimensions and altitudes attained by the cloud and stem following breakaway of the shock wave. High-speed Mitchell and Bell & Howell cameras and low-speed Eastman cameras were operated from two photostations for the three airdrops in Yucca Flat and from only one station for TS-1 and the four tower shots.

The cloud-tracking program utilized one station only. It was located at Mt. Charleston. This station was equipped with low-speed Mitchell and K-17 cameras. This study was undertaken for the three Yucca Basin airdrops only.

Results of analysis of these films by EG&G are listed in a memorandum issued as EG&G-OUT 996. A summation of these data is presented in Table 7.1. Cloud height and size are shown at 5, 15, and 30 sec after detonation for the first four shots. Owing to the fact that the tower shots were all predawn, no data could be obtained later than 5 sec on any of these. No films could be measured on TS-6.



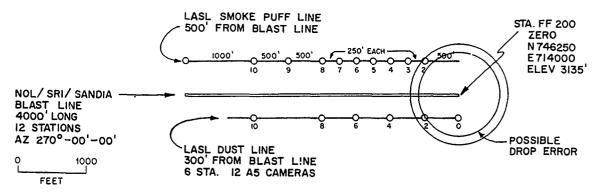


Fig. 7.1 - Blast and dust station arrangement, TS-1.

### 7.3 LUMINOUS EMITTANCE AS A FUNCTION OF TIME

General Radio slit cameras using continuously moving 35-mm film were again employed during Tumbler-Snapper in an attempt to determine the range of bomb-light levels and the curve of this light as a function of time. The basic method of obtaining these records has been described previously. To ensure at least one usable record for each degree of light intensity, a series of neutral-density filters in steps ranging from 0.5 to 3.0 was placed across the slit. Band-pass filters covering the blue, yellow, and infrared band were also used to permit determination of the spectral quality of the light emitted by the bomb.

An attempt was made to analyze these slit records using the Jarrell-Ash microphotometer pictured in Fig. 7.2. This instrument consists essentially of a moving film transport which passes across a slit. Light is projected through the slit onto a photocell which is, in turn, connected to a chart recorder. The trace thus obtained on chart paper shows variations in density along the strip of film. The film spools and chart spools may be adjusted so as to give a time resolution of about  $10~\mu sec$ .

The evaluation of the data thus obtained has run into several trouble areas which will require more extensive research, mainly in the study of emulsion sensitivities. It is not felt advisable to present the data obtained to date from the General Radio slit records until a more thorough study has been undertaken. It may be reported, however, that slit-record data coupled with density readings taken from Rapatronic plates have aided in obtaining the general shape of the light curve as a function of time. The data have also been helpful in predicting camera exposures required for operations following the Tumbler-Snapper series.

## 7.4 DISC CAMERA

Instrumentation suitable for yield determination from aircraft was again required on this operation. Accordingly, the Special Weapons Command installed an EG&G Disc camera in B-50 #7169 for use on TS 2 to 4. This aircraft was used as the drop aircraft on TS 2 and 3 and accompanied the drop aircraft on TS-4.

The principle and the operation of the Disc camera have been discussed generally in a previous report<sup>1</sup> and will be discussed in more detail in a forthcoming report.<sup>2</sup>

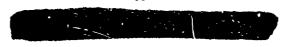
The Disc camera operated satisfactorily in all cases, giving measurable traces from all three streaks. Tables 7.2 to 7.4 summarize data  $\sigma$  cained from these records. Separate curves of diameter vs time for each trace are shown in Figs. 7.3 to 7.5, indicating the close agreement of all three traces. Plots of  $\phi$  vs time, comparable to those for the Eastman records previously discussed, are presented in Figs. 7.6 to 7.8. It may be observed that very close agreement exists between Eastman and Disc camera records in all cases.

### REFERENCES

- 1. Technical Photography, Buster-Jangle Project 10.3 Report, WT-417, December 1952.
- 2. Airdrop Instrumentation, Disc Camera, Greenhouse Report, Annex 1.9, Part III.

Table 7.1—SUMMARY OF CLOUD-TRACKING DATA

	<del>                                     </del>			NAME TO	MBLEE-S	NAPPER	DATE	JOB NO
<del></del>	Phot /=		HEIGHT					
5 HOT-	HeIGHT METERS	Time (sec)	ABOVE BURST (METERS)	(METERS)	VERT. THICK (METERS)	STEM WIDTH (METERS)		
1	242	5	155	500	195	70		
<del></del>		15	415	430	169	40	<del> </del>	
		30	738	640	205	115		
<del></del>				<b></b>				
2	338	5	139	270	237	-		
		15	393	400	385			
···		30	799	570	295	83		
3	1051	ક	265	720	270	-		
		15	642	990	410			
		30	1390	1255	250			
4	317	S	276	540	345	190		
		15	733	818	Z84	135		
<del></del>	-	30	\390	1090	280	200		
5	96	5	26	505	230	185		
		15	-	_		_		
		30	-					
6	96	e:	No DAT	A AVAIL	ABLE			
		15	, ,	•				
		30	и к	ч				
٦	96	5	131	485	<b>2</b> 50	240		
	L	15						
		36				-		
8	96	5	6	<u>५</u> ७०	375			
<del></del>								
	<del></del>	30						





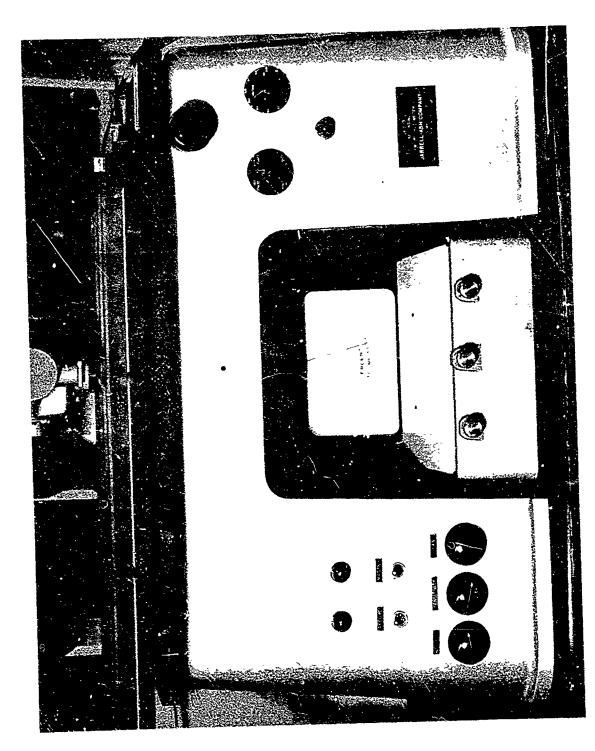


Table 7.2—DISC CAMERA SUMMARY, TS-2

				NAME		DATE		JOB NO
Time tris	245	Dian	reter (m	chere)	-	\$(m/ms2	<i>(</i> 5)	
		Outer	Midde	Innor	Outh	middle	Inner	<b> </b>
		Trace	Trou	Trace	Trace	Trace	Trace	
<del> j</del>						<del> </del>		<del> </del>
1.01	,9960	48.60	47.61	48.38	48.40	47.42	48.19	<del> </del>
152	'842R	58.62	54.19	54.41	42.04	45.83	46.02	<del> </del> -
2.53	·7%33	44.39	62.75	63.74	45.94	44.63	44.87	
	-6898	68.56	67.25	67.25	44.42	<del>                                     </del>	43.97	<b></b>
10E	16410 5715			<del>}</del>	43.45	43.11	43.11	╂
4.05		74.92	73.39	73.28	42.76	41.94	41.84	<del> </del> -
6.08	·5228	80.52	83.04	78.22	42.10	41.01	40.50	<del> </del>
7.09	.4568	89.08	84.66	83.37	41.10	39.59	<del></del>	<del> </del>
	.4443	90.94	88.53	89.30	40.69	39.33	39.88	<del> </del>
7.60		92.117	89.73	90.50	40.40	38.86	39.20	
8.10	.4227	93.90	91.38	92.15	39.69	+		<del> </del>
8.61			92.70	94.02		38.63	38,95	<del> </del>
9.12	,4130	96.76	94.56	94.67	39.37	39.23	38.88	<del> </del>
9.42	2400		95.33	95.55	39:12		37.84	
10.13	,3985	97.96	96.65	42.23	38.79	33:35	37.04	<del> </del>
18.63	13813		98.18	78.07		37.5!	37.94	<del> </del> -
11-65	13813 13745	101.9	99.39	1,0.01	38.63	37.44	\$1.74	<del>├</del> -
12.15		1017	44.54	99.72	38.16	37.22	36.73	<del> </del>
12.66	3683 3622	104,1	101.6	124.,0	37.71	36.80	36.75	<del> </del>
13.17	13666	10411	101.0	101.6	31.11	36.80	36.23	<del> </del> -
15.67	.3513	116.2	103.9	1000	<del></del>	36.50	-	<del> </del>
14.69	.3413	110.4	106.0		37.31	36.18	<del> </del>	<del> </del>
15.19	.3368	1141	106.0	105.4	37.68	36.13	35.50	<del> </del>
15.70	.3324	111.3	107.9	103.4	37:00	35.87	33134	<del> </del>
	3242	1	109.5			35,50		<del>                                     </del>
17.22	13203		10 10 3	109.4		3.00	75.04	<del> </del>
18.23	,3131	11514	<u>-</u>	11010	36.13	<del> </del>	33,01	<del> </del>
18.74	.3096		112.8	<del> </del>	361,2	34,92	<del> </del>	<del> </del>
18.17	.3064		110-0	112.0		34,1-	34.32	
19.75	3032	117.9			35.75	<b></b>	13.7	<del>                                     </del>
	.2944	<del></del>	114.2	114.9		33.62	83.80	<del>                                     </del>
21.78	. 2916	121.8	113.5	<del>                                     </del>	35.55	35,45	+	<del>                                     </del>
23.29	.2839	,,,,,		117.2	33,33	<u> </u>	35.27	1
	.2768	125,6		1	34.77		+	<del>                                     </del>
24.81	.2746	1/531.6		118.9		<del> </del>	32.65	<del> </del>
26,38	5075	1267		\"·"·"	24.24	<del> </del>	136.65	1
27.35	.2662	1,00.1		12:01	34.25	<del> </del>	32.24	<del> </del>

Table 7.3—DISC CAMERA SUMMARY, TS-3

				NAME		DATE		JOB NO
Time (ms)	t 215		Drameter (		ф (m	ms 2/5)		
1		Outex	middle	Inner	Outer	middle	Inner	
		Trace	Trace	Trace	Trace	Trace	Trace	<del> </del>
			0.00					<u> </u>
1.05	1599,	89.60	81.88	89.60	88.89	87.19	88.89	<del> </del>
1.53	·8436	100.7	99,90	99.90	84.95	84.27	84.57	<del> </del> -
2.04	<u>17519</u>	102.6	109.1	110.8	77.14	82.03	83.31	ļ
2.56	. 6866	109.4	116.8	119.4	75.11	80-19	81.98	<b></b>
3.67	- 6385	123.9	123.6	126.9	79.11	78.92	81.03	<u> </u>
3.59	4000.	130.0	<u> </u>		78.05			<u> </u>
4.09	·SU93	135.5	136.0	139.9	77.14	77.42	79.65	
4.60	,5431	140.8	ļ		76.47			<u> </u>
5.11	15207		146.7	149.7		76.39	17.95	
5.62	,5013	150.0			75.20			
6.13	.4842		156.6	160.6		75.83	77.76	<u> </u>
6.64	.4690	158.9			74.52			
7.15	.4553	163.6	166.2	169.8	74.49	75.67	77.31	
7.67	4427	168.0	ריורו		74.37	76.01		
8.18	,4314	173.0	175.1	177.8	74.63	75.54	76.70	
8.69	1154		179.4	183.9		78.55	17.44	
9.20	.4116		185.1	186.5		75.36	7676	
9.71	.4029		186.1	190.3		74.96	74.65	
10.22	.3946		190.4	195.1		75.13	76.99	
10.73	.3970		193.3	197.6		18.25	76.47	
11.24	.3749		192.8	301.5		73.24	76.46	
11.75	.3712			204.5			76.32	
12.26	.3670		<u> </u>	208.5			76.52	,
12,78	.3609		1	8.115			76.44	
13.29	.3553			213.4			15.82	
13.90	.3500							
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			J			<u> </u>		<b>-</b>

Table 7.4—DISC CAMERA SUMMARY, TS-4

				NAME		DATE		JOB NO
Time (ms)	7-2(3	Die	uneter (med	are)	40	m/ms 2/5		
tare (ins		Outer	Middle	Inner	Outer	middle	Inner	<del> </del>
		Trace	Trace	Trace	Thou	Trace	Trace	<u> </u>
			<del> </del>				1	<b></b>
1.01	03 69.	72.5	73.3	74.9	72,2	73.0	74.6	
1.52	184 88	83.8	84.0	85.6	70.9	71.0	72.4	<del></del>
2.02	·7548	957	92.8	94.6	70.0	70.0	71.4	ļ
7.53	898	49.6	100.9	102.4	68.7	७५.७	7.6	<del>                                     </del>
3.04	.6410	107.0	<u> </u>	ļ	€8.€	<u></u>		
3.54	.6031		113.4	114.9		68.4	69.3	
4.05	.STIS	118.6	<u> </u>	<del> </del>	67.8			
4.55	<b>.</b> डपडर		123.8	125.4		47.5	C8.4	
5.06	.5228	127.9		<u> </u>	60.9			
5.57	.5031		131,7	134.7		64.3	67.8	<u> </u>
L0.0	.4861	136.3			66.3			
6.58	5054		140.3	142.6		66.0	67.1	
7.09	.4568	143.4	144.2		65.5	65.9		
7.59	,4445		148.6	150.6		66.1	66.9	1
8.10	1664.	152.9	150.7		66.2	6,3		
8.60	9554.			157.8		<u> </u>	66.7	
9.11	.4132	159.9	<del></del>	1	66.1		+	
<del>''''</del>		131.1	<del>                                     </del>	<del> </del>			<del> </del>	<del></del>
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			<u> </u>	<del></del>		<i> </i>		

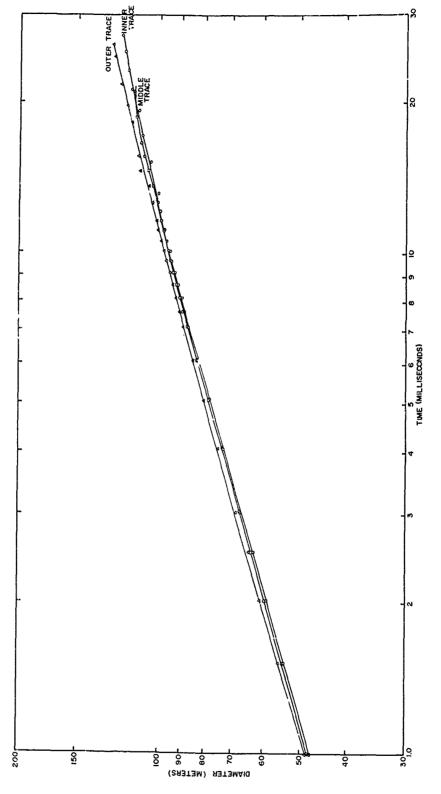
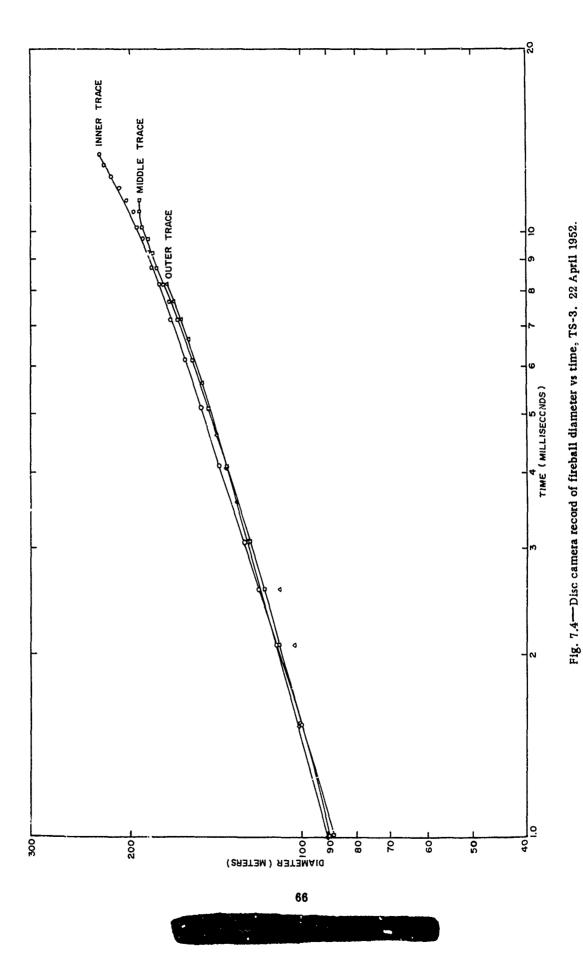


Fig. 7.3-Disc camera record of fireball diameter vs time, TS-2. 15 April 1952.



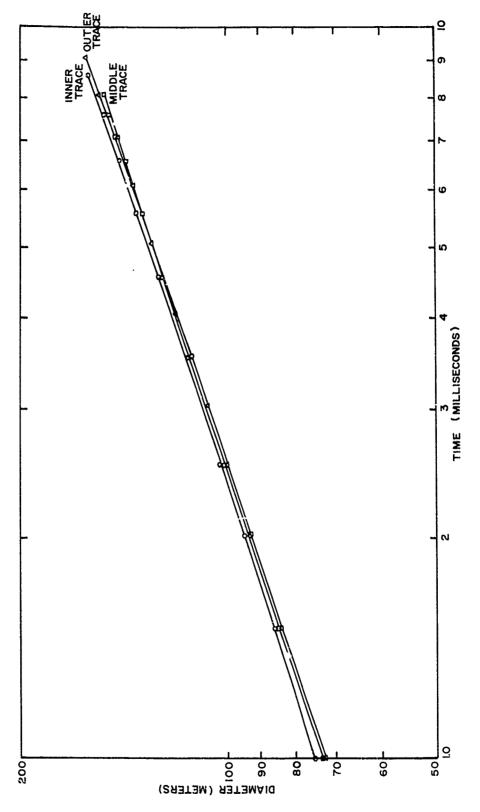
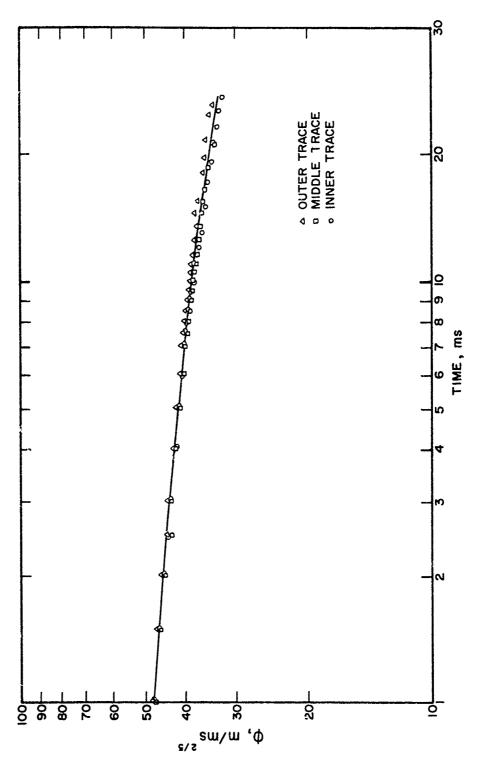


Fig. 7.5-Disc camera record of fireball diameter vs time, TS-4. 1 May 1952.



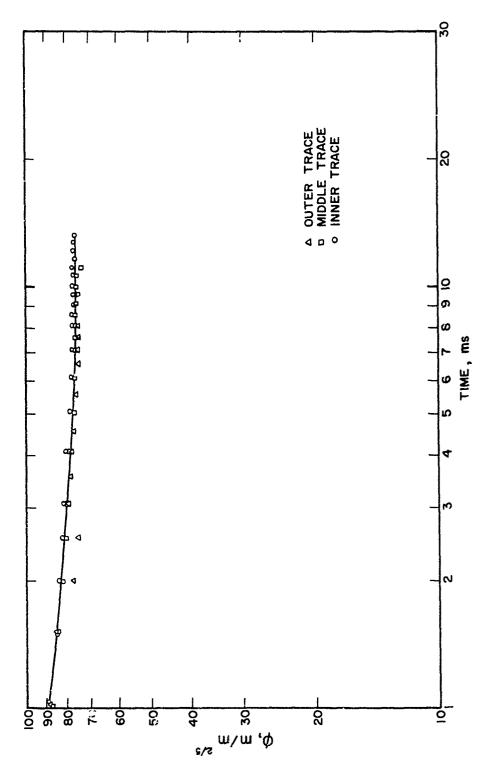


Fig. 7.7—Disc camera record of  $\phi$  vs time, TS-3.

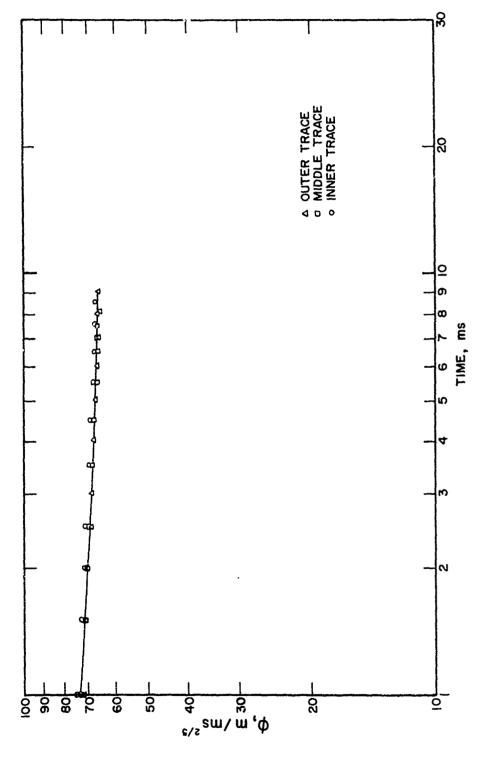


Fig. 7.8--Disc camera record of  $\phi$  vs time, TS-4,

APPENDIX A

### CAMERA DATA SHEET

TEST HE Drap DATE 430/32 STA. F-360
Tumbler 09:30 Truck 1

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#### CAMERA DATA SHEET

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REMARKS & NOTES				CAMERA		TIME			INS
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## CAMERA DATA SHEET

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	3000	16	1513			63	ET1245
	11	9	1493				RC622
	<u>7</u> 70	2	1317				RC 549
	3000	25	1520				ETI223
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	;t	6	1318			ч	RY187
	30 FT/S	GR- 2					
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		K-529				480	774529
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#### CAMERA DATA SHEET

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# CAMERA DATA SHEET TEST TS-1 DATE 4/1/52 STA. F-361 09:00 TRAILER 4

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		~	FR./SEC.			MAG.	OPER.	FCC. LGH.	
Raise Front 15%	FREND	PUR POSE S.P. 9	100	MH-7	742			400mm	52236
	1	5.6.8		3	734				52237
	UNDER EXPOS	GND. STRIKE		S	747			+	52238
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### CAMERA DATA SHEET

TEST TS-1 DATE 4/1/52STA. F-361

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## CAMERA DATA SHEET

TEST\_T5-1 DATE 4/1/52 STA. F-360

	F	EMARKS	S & NOTES				CAMERA		TI	ME	<u> </u>	LE	MS	140
			PURPOSE	∿F	R./SEC.		SERIAL				FOC		SERIA	_
TOO 4	EWY.	EXPO6	S.P. 7+8	8-105 R	NUNG	E-17	1496		1-2	-3+	15	2	RC27	3
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			SHOCK	8-105 F	DHINN	11	1521		1-8	-3+	2	5	RYITE	<u>5</u>
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			SURVEY	SHUTTER	1/2005	W-148	148	<u> </u>	<u> </u>		16	<sub>2</sub> 5	148	_
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#### CAMERA DATA SHEET

TEST T5-1 DATE 4/1/52 STA. F-360

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			TERS				POWER		TIM	NG			ERIALS		
CODE		ND	COLOR			VERT			ON	OFF	FM.	VEL.	ZERO	POS.	NO.
13078	5-XX	0	0	4	13°-07'1	0-36	12000 Shu	tonc	-2.55	SELF +45	53	200-4	4	A	E-17
777	Вх	Ц	0	_	11-27	<del>                                     </del>	$\sqcup \bot \sqcup$		<u> </u>		Ш	10	:0	В	20
76	5-XX	Ц.	12	<u> </u>	9-45							9	9_	<u></u>	21
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### CAMERA DATA SHEET

TEST\_TS-1 DATE 4/1/52 STA. F-362
09:00 Truck 2 Failer 5

DEMARKS & NOTES		1	CAMEC		TIME		D Truck 2
REMARKS & NOTES	a, ED IEE		SERIAL	04.1	OPER.	FOC. LGH.	CEDIAL
PURPOSE	~FR./SEC	+	ļ	MAU.	<u> </u>		
	3000	E-8	1445		15 SEQ.	63mm	ETIZS4
•	<b></b>	15	1494	<del> </del>	ļ		RC606
STEM	8-105 RUHNIN		1454		1-2-3+	152	RC245
AIETD	3000	16	1513	ļ	5 <sub>25</sub> 250.	63_	ET1245
,	ii .		1493	ļ	<u> </u>		RC622
COLOR	8-105 RUHHIN	<u>2</u>	1317		1-2-3+		RC549
AIEID	3000	25	1520		3rx SEQ		ET1223
h.	11	24	1522	ļ		+	RC 539
SHOCK	8-105 RUNNIN	3 4	1321		1-2-3+	25	RY165
11		6	1318		ti	11	RY187
ND 0,0.5,1.0,1.5,2.3,3.0 LIGHT (T)	30 1/s	GR-2	581		<u>"</u>	-	
SURVEY	SHUTTER 1/2009	W-147	147	ļ		165	147
u	" 1/150 E	K-529	41-1194			4-80	774529
		-	<del> </del> -				
ROCKETS	100	MH-1	74B	<u> </u>		75	851764
R		5	743			75	B51805
CLOUD		BH-5	1093			25	281674
STEM	+	3	1095	<u> </u>		100	282345
HA 0,05,10,15,20,30 LIGHT (T)	301/s	GR-5	667			_	
si # #		6	<u>ଜେ</u> ୨		+	_	-
YIELD.		R-14	14		3000µg	480	77395%
ė.		24	24		2632	l i	3958
F,B		4	4		17.7		3947
· ·		19	19		49.9		2890
ч		18	18		213		3955
*		29	1		780		3954
SPECTR.		12			36.3		3500
ц		17			80.0		3951
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#### CAMERA DATA SHEET

[EST T5-1 DATE 4/1/52 STA. F-362 09:00 Truck 2 Trailer 5

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# CAMERA DATA SHEET TEST\_TS-1 DATE 4/1/52 STA. F-DUST 09:00

REMARKS & NOTES	,	CAMERA		TIME		LE	NS
∼FR./SEC.		SERIAL	MAG.			. LGH.	SERIAL
ALL SHUTTERS AT GO - (1/3 FR INTERVAL EXPOSURE)	MA5-		27-i		35	mm	765260
	22		22-1				764-794
	6		18-2				76A 80S
	19		19-1				763 975
	18		18-1				764 810
	3		3-2				318
	9		9-1				765257
			1-1				763770
TOWER	26	ļ	26-2		L		763970
FILM JAMMED - DID NOT RUN	5	<u> </u>	5-1				995
	16		16-1				764793
	25		25-1				788
FILM JAMMED - DID NOT RUN	8		1-03				
POLE	17		17-1			<u> </u>	763977
	<u> </u>				<u> </u>		
VELOCITY MARKER CALIBRATION		<u> </u>					
MARKER VELOCITY (CPS)	ļ	<b> </b>					
3 1.95	<u> </u>		ļ		<u> </u>		
5 1.95							
6 1.93	<u> </u>	<u> </u>					
7 1.95	ļ	<u> </u>			<u> </u>		
8 1.97	<u> </u>	ļ. ——			<u> </u>		
9 1.97	<u> </u>	<u> </u>	<u> </u>		<u> </u>		
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#### CAMERA DATA SHEET

TEST TS-1 DATE 4/1/52 STA. F-DUST

CODE	PERF.	EMUL	S.I	FIL	TE	RS	APER.	AIMI	NG	POW	ER	T	IMI	NG		MA	\RI	KERS, S	ERI	ALS	RACK	CAM
8C       11       "       "       22         87       2.3       F202       0       2-6       F364       6         88       11       "       "       12       "       "       15         89       2.3       F204       +1°       2-3       F365       18         90       8       "       "       "       "       "       "       3         91       2.3       F206       0       -45       +175       2-7       F366       9         92       8       "               " <t< td=""><td>1 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>_</td><td></td><td></td><td>_</td><td>_</td><td>_</td><td></td><td></td><td></td><td></td><td></td></t<>	1 1											_			_	_	_					
8C       11       "       "       22         87       2.3       F202       0       2-6       F364       6         88       11       "       "       12       "       "       15         89       2.3       F204       +1°       2-3       F365       18         90       8       "       "       "       "       "       "       3         91       2.3       F206       0       -45       +175       2-7       F366       9         92       8       "               " <t< td=""><td>13085</td><td>MF</td><td>1</td><td>٥</td><td>-</td><td>&gt;</td><td>5.3</td><td>F200</td><td>+10</td><td>241</td><td>DC</td><td>-1</td><td>45</td><td>+7</td><td>5</td><td>-</td><td>- 1</td><td>2-5</td><td>-</td><td>-</td><td>F 363</td><td>MA5</td></t<>	13085	MF	1	٥	-	>	5.3	F200	+10	241	DC	-1	45	+7	5	-	- 1	2-5	-	-	F 363	MA5
87       2.3       F202       0       2.6       F364       6         88       11       "       "       1.1       "       1.9         89       2.3       F204       +1°       2-3       F365       18         90       8       "       "       "       "       "       "       3         91       2.3       F206       0       -45       +175       2-7       F366       9         92       8       "               "       "       "       "       "       "       1         94       2.8       F208               2-8       F367       26         93       5.6       " <td< td=""><td></td><td></td><td>7</td><td>T</td><td></td><td></td><td>=</td><td></td><td></td><td></td><td> </td><td></td><td></td><td></td><td></td><td>Ī</td><td></td><td>μ</td><td></td><td></td><td></td><td>1 1</td></td<>			7	T			=									Ī		μ				1 1
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90 8 " " " " " 3 91 2.3 F206 O -45 +175 2-7 F366 9 92 8 "   " " " " 1 94 2.8 F208   2-8 F367 26 93 5.6 " " " " " " 5 95 2.3 F210   2-9 F368 25 97 6.6 " " 20			T	$\top$			2.3	F204	+10							П		2-3			F3 <b>65</b>	
91     2.3     F206     0     -45     +175     2-7     F366     9       92     8     "           "     "           "           1       94     2.8     F208           2-8     F367     86       93     5.6     "     "     "     "     "     3       95     2.3     "     "     "     "     16       96     2.3     F210     2-9     F368     25       97     6.6     "     "     "     20				T				4	1)			Ti	,	1	_			16			n	
92 8 "			T				2.3	F206	0			-4	۱5	+1	75			2-7	_		F366	
34       2.8       F208       2-8       F367       26         93       5.6       "       "       5         95       2.3       "       "       "       "       16         96       2.3       F210       2-9       F368       25         97       6.6       "       "       "       20			T					11										ti .		Γ	W	7
93 5.6 " " " 5 95 2.3 " " " 16 96 2.3 F210								FZOB										2-8			F367	26
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	09:29 57	05 TRUCK	7

REMARKS	& NUTES		T	CAMERA		TIME		NS I
ET	PURPOSE	∼ FR./SEC	NO.	SERIAL	MAG.	OPER.	FOC. LGH.	SERIAL
0	GND STRIKE		E-17	14%		1-2-3+	152 mm	RC273
765	M7 I		20	1525				313
3750	<u> </u>		15	1519		<u> </u>		257
3000	44		10	1515		<u> </u>		358
55220	3		26	1518				334
1500		<u> </u>	27	1514		1	<b>*</b>	253
	YIELD	3000	7	1443		15 550.	63	CSS173
			12	1512	<u> </u>	5,2		1207
	<u> </u>	+	18	1517	ļ	3.5 "	+	1253
	COLOR	500	11	1521	L	1-2-3+	25	RY175
					<u> </u>	<u> </u>		
	SURVEY	1/200 SEC	W-148	148			165	148
		1/150 SEC			<u> </u>	ļ	480	774528
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#### CAMERA DATA SHEET

TEST T5-2 DATE 4/15/52 STA. 7-360

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### CAMERA DATA SHEET

TEST\_TS-2 DATE 4-15-52 STA. 7-361

OP:29:57.05 Truck & Trailer 4

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REMARKS & N	OTES			CAMERA	·	TIN		L		NS
	PURPOSE	∼ FR./SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC	LGH.	SERIA
	YIELD	3000	E-8	1445		15%	ŒQ.	6	3~~	ET1254
	n	ti.	15	1494		"		"		RCGOG
	STEM	500	1	1525		1-2-	+6	19	2	RC245
	YIELD	3000	16			242	SEQ.	6	<del>ನಿ</del>	ET124
	11	11	9	1493						RC622
(ROCKETS)	SHOCK	500	2	1317		1-2-	3+			RC549
	YIELD	3000	25	1520		300	SEQ.			SSITE
	u	14	24	1522		"			1	RC539
	SHOCK	500	4	1321		1-2-	3+	2	5	RYIG
	COLOR	11	6	1318	]			,	1	RY18
N.D. 0,06,1.01.5,2.3,3.0	(T) 7HQ (L	30√s	GR-2	581		,				
						_				
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RAISE FRONT	ROCKETS	100	MH-4	745				100	mm	BF852
II *	11		8	744				75	5	85198
	CTOND	<u> </u>	BH-E	1096				2	5	53903.
	YIELD		R-8	8		50	25	48	sc	77394
	11		10	10		40	95			396
	FIREBALL		25	26		11.	В			469
			31	31		31.	.7			394
			9	9		10	3			469
			33	33		41	1			395
	SPECTR.	<del></del>	5	5		74	95			399
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### CAMERA DATA SHEET

TEST T5-2 DATE 4-15-52 STA. 7-361
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06		1	4	5.6	1	١,			II.		iq.			П			7	7	E	9
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#### CAMERA DATA SHEET

TEST 15-2 DATE 4-15-52 STA. 7-362 09:29:57:05 Trailer 5

REMARKS &	NOTES			(	AMERA		TIN	4E		LE	NS
	PURPOSE	<b>∿FR.</b> /	SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC	. LGH.	SERIAL
PAISE FRONT	ROCKETS	100	2	MH-I	748			l	7	5mm	BS1764
u ti	"			5	743				8	0	UF 6935
	מטט			BH-2	1093				2	5	281674
	STEM	+		3	1095				1	52	BF2355
N.D 0,05,1.0,1.5,20,3.0	LIGHT (T)	30	/5	GR-5	ଓଡ଼ିଆ				_	•	
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	YIELD.			R-14	14		59	90	48	0	773952
	u			24-	2A	L	26	15			395 <b>8</b>
	FIREBALL			4-	4		18	3.3			3947
				19	19		49	ه).(ه			5830
				13	16		20	5			3955
	<b>†</b>			29	29		7	73			3954
	SPECTR.			12	12		41	0.5			3960
	ll .			17	17		8	4	1		<u> </u>
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	SURVEY	1/200	SEC.	W-147	147				10	5	147
		1/150	SEC.	K-529	41-1194			<u> </u>	41	06	774529
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### CAMERA DATA SHEET

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( !	EMULS.										Р	ow	ER	<b></b>			_		_				RACK	
CODE		-	4	COLOR			_	RIZ.	İ	_				_	ON	<del>-</del> -	FF	FM.	ļ		ZE	RC_	POS.	}
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24	"	$\vdash$	+		_	45°	<u> </u>				_	<b>├</b>		<b> </b> _	┼	ļ	_	-	_		Щ		PP	5
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### CAMERA DATA SHEET

TEST TS-2 DATE 4-15-52 STA-7-248 \$
09:29:57.05 Dust & CLOUD

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#### CAMERA DATA SHEET

TEST TS-2 DATE 4-15-52 STA5. 7-246, 09:29:57:05 DUST & CLOUD

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#### CAMERA DATA SHEET

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### CAMERA DATA SHEET

TEST TS-3 DATE 4-22-52 STA. 7-361
09:30:10:00 Truk 2 & Trailer 4

REMARKS & N	IOTES			CAMERA		TIM	Ε		Lt	NS
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## EDGERTON, GERMESHAUSEN & GRIER, INC. CAMERA DATA SHEET

TEST	TS-3_	DAT	÷	4-22-5	2 ST	Ά.	7-361

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## CAMERA DATA SHEET

TEST T5-3 DATE 4-22-52 STA. 7-362
09:30 10:02 TRAILER 5

REMARKS &	NOTES		(	CAMERA		TII	ME		LE	MS
	PURPOSE	∼ FR./SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC	. LGH.	SERIAL
RAISE FRONT	ROCKETS	100	WH-1	148				5	O	LF6996
6 4	tı		S	743				н		LF 6935
	Crow		8H-5	1093				2	5	281474
	STEM	į	3	1095				)S	2	BF2355
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	YIELD		R-14	14		10,7	دسه	4-8	30	173952
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	FIREBALL		4	4		16	و.			3947
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			18	18		48	60			3955
	+		29	29		7	35			3954
	SPECTR.		12	12		2	5			3960
	tr		17	17		7	9.8			3951
	SURVEY	1/200 5	W-147	147				1	<u>5</u>	147
	SURVEY	1/150 5	K-529	41-1194				4	80	774529
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### CAMERA DATA SHEET

TEST TS-3 DATE 4-27-52 STA. 7-362
09:30:10 02 TRAILER 5

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### CAMERA DATA SHEET

TEST T5-3 DATE 4-22-5 STAS 7-248,
09:30:10:02 DUST & CLOUD

REMARKS	8 NOTE				(	CAMERA		TIM	4E		LE	NS
TM CALIBRATION		PURPOSE	∿FR.	SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC	LGH.	SERIAL
TM 3 VEL.(CPS.)		200		2	MAS- 27					35	TUTA	765260
•	1.95	*			22							764794
	1.93	202			6							76480
	1.95	4,			19							765976
8	1.97	204			IB.							764810
	1.97	11			28							762779
	1.98	206			9							76525
	1.98	41		1	24							76480
* AIM DOWN BLAST		SHOCK DUST	35	SO SE	F16-3							46039
	10.13.20	208	3:		MAS-							76500
		1		1	16							76479
				3	15							76524
		210			4				Π			76396
		1			1 11						,	76537
MAIM DOWN BLAST	LINE			8	17					7	5	76495
		201		ۇ. چ						3	5	76338
		204		3	26							76357
* AIM ~ 180 ANAY FROM		DUST		,						1	,	76377
# AIM AT BLAST STAT	IONS	t.		4 2		30825		í –		1.	7	93346
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"/5ee 1 of 209				1 8	3	734		1				52237
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	- 125 CV					12010	1	†		<del> </del>		
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	00 SEC.	1			<del>1</del> -	AC 44 191117	<del> </del>	1		15		MF2545
	25 <u>Sec.</u>	<del></del>		aries ''		4044	<del>                                     </del>	<del> </del>	_	<del>                                     </del>	b4	EC314
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TEST TS-3	DATE 4-22-54S	TAS. 7-248
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## CAMERA DATA SHEET TEST TS 4 DATE 5-1-52 STA. 7-360 09:29:58.6 TRUCK 1

REMARKS & NOTES  PURPOSE	REMARKS & NOTE	ES			CAMERA		TIM	E	UJ.	29158.		ï`
My 7 500 E-17 1496 1-2-3+ 152mm RC273  6 20 1525 313  5 21 1519 257  4 10 1515 358  3 26 1518 334  2 7 1514 7 253  YIELD 3000 7 1443 1550 63 ET1229  12 1512 25 " 1207  18 1517 35 " 1253  COLDR 750 11 1521 1-2-3+ 25 RY175			R./SEC.			MAG.			FOO			1
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### CAMERA DATA SHEET

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PERF.	EML	JLS.	FIL	TE.	RS	APER.		AIMI	NG		F	OA	VER	1	TIMING				MAR	KERS, S	ERIALS	RACK	CAM
CODE			CM	CC	DLUR			HORIZ. VERT.							C'4		OFF		FM.		ZERO	POS.	NO.
13378	B	<u> </u>	0	1	5	5.	6	22° 15′L	æ	VEL	150	200	SHU	П	-2.	55	58	LF	23	200-4	4	A	E-17
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#### CAMERA DATA SHEET

TEST\_T5-4 DATE 5-1-52 STA. 7-361
09:23:58-6 TRUCK 2 & TRAILER 4

REMARKS &	NOTES		-	CAMERA		TIME		INS
	PURPOBE	∿FR./SEC.	NO.		MAG.	OPER.	FOC. LGH.	
	YIELD	3000	€-8	1445		1 SEQ.	63mm	ET:254
	"		15	1494			"	RCGOG
	W) 8	500	1	1525		トマ・ヨキ	152	RC245
	YIELD	3000	16	1513		542 SEO	63	ETIZAS
	1,	**	g	1493		*		RCGSS
	M78	500	2	רוצו		1-2-3+		RC549
	VIELD	3000	25	1520		3 <sub>28</sub> ≥EÚ		£71223
	¥	11	24	1522		u		RC 539
	STEM	500	C-	1321		1-2-3+	25	RYIGS
AIM AT STA. 202	COLOR	750	6	1318		<u> </u>	6	RY187
N.D.O.O.5,1.0,15,2.3,3.0		30 1/sec	GR-2	581				
<u></u>			[ 				<u> </u>	
RAISE FRONT	ROCKETS	100	MH-4	745			100	BF8525
	<b>4</b>		8	744-	L		75	BS1764
<u> </u>	cioup		G	746			25	<i>E8e</i> 7V
	YIELD		8-8	8		ويره€1,03	480	773944
	11		10	10		17,455	1	3961
	FIREBILL		26	26		9.8		4696
			31	31		30.1		3948
			9	9		99.8		4694
			33	33		403		3950
	SPECTR.		5	5		26,550		3956
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#### CAMERA DATA SHEET

TEST T5-4 DATE 5-1-52 STA. 7-361
09:29:58.6 TRUCK 2 TRAILER4

PERE	EMULS.	FII	TERS	APER.	AIMI	NG	POI	WER	TIM	NG			SERIALS		
CODE			COLOR	L.	HORIZ.				ON	OFF	FM.		ZERO	4	
13303	MF	0	12	4	0,00		1200	c 40/80			22	200-B	8	A	E-8
04	"	-		5.6	1,	n	T		T		ī	7	7	В	15
80	BX	0		*	28-02L	LEYEL		SHUNT		- -		12	<del> </del>	c	1
05	MF	0		4	0-00	3-30		40/80	-1.5			8	8	D	16
06	ŧ.	-		5.6	11	t,		11	11			٦	7	E	9
79	BX	٥		н	21-5GL	LEVEL		SHUNT	-2.5			12	12	F	2
07	MF	0		4-	0-00	3-30	$\Gamma T$	40/80	-0.5		П	8	8	G	25
08	''	1		5.6		•	$\Box$	"	11			7	7	н	24
14	"	1		4	1	5-10		SHUNT	-2.5			12	12	I	4
15	ECN	0	0	5.6	4°41'L	*	П	11		+	П	8	8	L	6
27	SXX	STES #4	IZ.	_	0-00	LEVEL	1		+	+35	T	12	12	к	GB-5
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13381	WE	ī	12	54 G8	0-00	LEVEL	120	DC	-155	+459	=	100-1	=	0	MH-4
82		0	"	5.6 90		11						6		N	8
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54	"								-2.5					S	10
45	HRHS	Ц							Ш		10			T	26
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45	EKTA	Ц	CC40M		Щ.	$\sqcup \bot$	<u>                                     </u>		Ш		Ш		$oldsymbol{ol}}}}}}}}}}}}}}}}}$	X	5
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#### GAMERA DATA SHEET

TEST\_TS-4 DATE 5-1-52 STA. 7-362
09:29:58.6 TRAILER 5

RAISE FRONT PURPOSE VFR/SEC NO. SERIAL MAG. OPER. FOC.LGH. SERIAL " ROCKETS 100 MH-1 1748	REMARKS &	NOTES		(	AMERA		TIN	IE		LE	NS
" RUCKETS 100 MH-1 748	RAISE FRONT	PURPOSE	∼ FR./SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC	LGH.	SERIAL
CLOUD BH-2 1093		RUCKETS	100	WH-1	748				75	mm/	BS1984
STEM 5 1096   ISZ 3F2355  N.D. O.D. S. I.O. I.S. S. O.				5	743				50	>	LF6935
STEM 5 1096   IS2 3F2355  N.D. 0,0.5,1.0,1.5,2.0,3.0 LIGHT (T) 30 / 5 GR-5 667		CLOUD		BH-2	1093				25	5	291674
N.D. O.D. S. 1. O. 1. S. 2. O. 3. O. 1. C. HT (T) 30/S GR-S 667 — — — — — — — — — — — — — — — — — —				5	1096				15	2	3F2355
YIELD R-14 14 10,756,95 480 773952  "	N.D. 0.0.5. 1.0.1.5.2.0.3.	O LIGHT (T)	30//s	GR-S	667				_	-	
"	11		ti .	6	9				-		_
"											
FIREBALL 4 4 4 16.9 3947  19 19 49.2 2890  18 19 4860 3955  29 29 785 3954  SPECTR. 12 12 215 3960  17 17 79.8 3951		YIELD		R-14	14		10,7	علاعة	46	30	773952
19 19 49.2 2890   18 19 4860 3955   29 785 3954   SPECTR. 12 12 215 3960   17 17 79.8 3951   SURVEY 1/2005 W-147 147 — 165 147		4		24	24		73	35			395 <b>8</b>
19   19   49.2   2890   18   19   4860   3955   3955   29   785   3954   3960   3951		FIREBALL		4	4		10	9.0			3947
\$29 785 3954 \$PECTR. 12 12 215 3960 17 17 79.8 3951 SURVEY 1/2005 W-147 147 — 165 147				19	19		49	3.2			2890
SPECTR. 12 12 215 3960 17 17 79.8 3951  SURVEY 1/2005 W-147 147 — 165 147				18	18		48	60			3955
17 17 79.8 1 3951 SURVEY 1/2005 W-147 147 - 165 147		1		ප	29		7	35			3954
SURVEY 1/200 5 W-147 147 - 165 147		SPECTR.		12	12		2	15			3960
80842				17	17		7	9.8		<u> </u>	3951
80842											<u> </u>
80842				L							
		SURVEY	1/2005	W-147	147		_		16	5	147
			1/150 5	K-523	A-1194	<u> </u>		-	45	30	774529
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#### CAMERA DATA SHEET

TEST T5-4 DATE 5-1-52 STA. 7-362

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CODE			COLOR			RIZ.		_				N		FF							POS.	
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#### CAMERA DATA SHEET

TEST\_TS-4 DATE 5-1-52 STAS, 7-248,
09:29:58 6 DUST & CLOUD

REMARKS & NOTI	ES			1	AMERA		TIN		1		NS
	PURPO	SE OF	R./SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC	LGH.	SERIAL
DO NOT RAISE FRONT	GUNE	, 1	00 8	MH-7	742		1		400	mm	52236
Y	1		I '		734					1	52237
	+		1	2	747					<b>,</b>	52238
VEL MARK VEL (CPS)	DUS	T	35	MA5-		27-1			35	5	765260
3 1.95				22		52-1					764794
5 1.95				9		7-2					764805
G 1.93				19		19-1					763975
7 1.95			<u> </u>	18		18-1					764810
8 1.97				28		28-5					762779
9 1.97				9		9-1					165257
10 1.98	I			24		24.5					764807
11 1.98	I			8		8-1					764796
				13		13-1	<u> </u>	L.			765008
				16		16-1					764793
				15		15-1					765249
				4		4-1	<u> </u>				763%5
				11		11-1		! }			765317
LOOKS DOWN BLAST LINE			1	17		17-1	_		-	15	764357
						<u> </u>	<u>L</u> .				
· · · · · · · · · · · · · · · · · · ·	טם	ST	35	MA5-		14-1	<u> </u>		3	5	763387
DU	ST \$ 8	HOCK_3	50_	F16-3	ļ	<u> </u>	<u> </u>	<u> </u>			460392
		<u>র</u>	35	MAS-	<b></b>	26-5	<u> </u>				763970
LOOKS AWAY FROM BLAST LIN	-			1	<b></b>	1-2	<u> </u>	<u> </u>		<u> </u>	763770
LOOKS DOWN BLAST LINE	1	<u> </u>	4	2		2-1	<u> </u>		ļ		764-015
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#### CAMERA DATA SHEET

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#### CAMERA DATA SHEET

TEST\_TS-5 DATE 5-7-52 STA. 1-355
TRUCK | &TRAILER 4

REMARKS & NO	TES			CAMERA		TH	ME		LE	NS
Ps "/,"	PURPOSE	∼FR./S	EC. NO.	SERIAL	MAG.	OP	ER.	FOC. L	GH.	SERIAL
2×105 5-75 095947104	BREAKANAY	650	E-17	1496				152	****	RCZ73
5×10 <sup>5</sup> "		н	20	1525				lı		RC313
1,5x10 <sup>5</sup>	YIELD	3000	12	1512		Π		102	7	RY510
4×10 <sup>4</sup>			18	1517				u		ET415
1.5×105			7	1443				63		ETIZZ9
44104	; T	1	24	1522				ч		RC539
Z×105 5-74 CPERATION	STEM	650	27	1514				25		RY189
3×10 B-106 OPERATION		400	1	1454				p		RYIBS
N.D. D.O.S. 1.0,1.5,20,3.0		501/	5 GR-4	670					-	
						_				
2×103 Raise Front	BW SHOCK	100	MH-4	745	<del>                                     </del>			100		BF8525
103 " "	COLOR		8	744		<u> </u>		į,		BF9463
100 TILT ~ 16°	crond	<u> </u>	<u> </u>	746	<u> </u>	$ldsymbol{f eta}$	<u> </u>	25		VF983
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			10	10	<u> </u>	83	00			3961
	FIREBALL	<b>-</b>	Se	26	<u> </u>	9	8			4696
			31	31	<u> </u>	27	.5		[	3948
			9	9	<u> </u>	9	5			4694
	<u>`</u> _		33	33	<u> </u>	40	3			3950
	COLOR		5	5	ļ	16,8	00			3936
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#### CAMERA DATA SHEET

TEST TS-5 DATE 5-7-52 STA. 1-35;
TBuck 1 - TRAILER 4

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#### CAMERA DATA SHEET

TESTTS-5 DATE 5-7-52 STA. 1-356
TRUCK 2 & TRAILER 5

REMAI	RKS & NOTES			CAMERA		TIME		uck 2 \$ TF
Ps W/m2	PURPOSE	∼ FR./SEC.	NO.	SERIAL	MAG.	OPER.	FOC. LGH.	SERIAL
1.5×10 <sup>6</sup>	YIELD	3000	₹-25	1520		!	102	ET201
4 1 104			15	1494			"	RCI85
15×105		+	9	1493			63	RCGZZ
108	FIREBALL	8000	F8-3	8C-12		Ti	254	876314
107	#	ħ	F8-14	8C-L			"	876312
4×104	<b>AIE</b> r⊅	3000	E-16	1512			63	ET1245
106	FIREBALL	4-000	F:G-11	164-15			100	617343
106	à	11	FIG-R	16-163			45	617367
5×100	YIELD	3000	€-8	1445			63	ET1254
	1.5.2.3.3.0 LIGHT	50 /sec.	Q5-5	581				
							1	
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5×103 RAIS	E FRONT SHOCK	100	MH-I	748		T i	100	BF9465
103	"		5	743				BF8507
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n.p. 0,0.5,1.0,	1.5.2.0, 3.0 LIGHT	50/550	62-5	667		<del>                                     </del>	_	
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			19	19	<del> </del>	49.2		2890
			18	<del> </del>		210		395
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#### CAMERA DATA SHEET

TEST TS-5 DATE 5-1-52 STA. 1-356
TRUCK 2 1 TRAILER 5

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## CAMERA DATA SHEET TEST TS:5 DATE 5-7-52 STA. 4-248

REMARKS & NOTES	T -	CAMERA		TIME	LE	NS
PURPOSE ~FR./SEC	NO.	SERIAL	MAG.	OPER.	FOC. LGH.	SERIAL
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## CAMERA DATA SHEET TEST TS: 5 DATE 5-7-52 STA. 4-248

PERF.	EMULS.	FIL	TERS	APER.	AIMI	NG	POWER	TIM	NG	MAR	KERS,	ERIALS	RACK	CAM
CODE				SET.				ON	OFF	FM.		ZERO		
134-70	MF	Ţ	0	6.3 15°	3-03 R	3°55′	115AC	-155	+205	-	100-4-	_	A	M1-7
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72	BX	11		6.3 170°				1		1	1		С	5
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#### GAMERA DATA SHEET

TEST TS-6 DATE 5-25-52 STA. 4-355
TRUCK 2 & TRAILER 5

PEMARKS & NO	OTES		(	CAMERA		TI	ME		LI	NS
	PURPOSE	∼ FR./SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC.	LGH.	SERIAL
	CORE	3000	E-25	1520				102	2	ETZOI
	AIET D		15	1494				•		RCIBS
	n		9	1493				67	3	RC62Z
	FIREBALL	0008	F8-3	&C-12				25	q	876314
	YIELD	3000	E-16	1513				69		ET1245
	FIREBALL	4000	F16-11	16C-15				101	<b>&gt;</b>	6:7363
	0	h	FIG-R	16-168				и		617367
	COLOR	3000	E-8	1445				9	3	ETI254
N.D. 0,0.5,1.0,1.5,20,3.0	LIGHT	50 1/sec.	GR-S	581					•	_
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RAISE FRONT	SHOCK	100	MH-1	748	<del> </del>	<del> </del>	-	10		BF9465
	<del></del>		_	743	<del> </del>	<u> </u>				BF8507
BAIRD	<u> </u>	1	8H-2	1093						282354
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	YIELD		R-14	14		10'6	MODIS.	48	0	773952
			24	24	ļ	73	35			82¢£
			4	4		44	100			3947
			19	19	<u></u>	4	9.2			5890
			18	18		2	40			3955
			29	29		7	85			3954
Bus FM T	LLER LIGHT		12	i'2			٥			3960
		95ys (TT = 98.1)	17	17						3951
5 "	" "	11 11	5	5						3956
_	ELLER LIGHT		6	6	T	Γ	1	1		3949
	ELLER-SPEC		TR-B			~	0	400	64.	CASS EGILAIR
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#### CAMERA DATA SHEET

TEST TS-6 DATES-25-52 STA. 4-355

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#### GAMERA DATA SHEET

TEST TS-G DATE 5-25-52 STA. 4-356
TRUCK | & TRAILER 4

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REMARKS &				CAMERA		TIME		NS
	PURPOSE	∼ FR./SEC.	NO.	SERIAL	MAG.	OPER.	FOC. LGH.	SERIAL
	SHOCK	650	E-17	1496			152	RC273
	*	11	20	1585			11	RC313
	YIELD	3000	12	1512			102	84210
			18	1517			n	ET415
			7	1443			G3	ETIZZ9
	<del></del>	<u> </u>	24	1522		<u> </u>	•	RC539
	STEM	650	27	1514			25	RYI89
	COLOR	400_	1	1454	<u> </u>		u	RY183
ND. 0,0.5,1.0,1.5,2.0,5.	O LIGHT	501/5	GR-4	७२०				
W1.25 + BAIRD \$7-2079								
		- 1						
RAISE FRONT	SHOCK	100	MH-4	745		i	001	BF8525
RAISE FRONT	CronD		8	744			"	BF9463
200	4	-	6	746			25	VF983
			R-B	8		4940	480	773944
			10	10		8300		3961
			26	26		9.8		4696
			31	31		27.5		3948
			9	9		95		4694
			33	33		403		3950
VIEWS TOW	ER AREA 2		WH-3	734		_	400	52237
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### EDGERTON, GERMESHAUSEN & GRIER, INC. CAMERA DATA SHEET

TEST TS-6 DATE 5-25-95TA. 4-356
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#### CAMERA DATA SHEET

TEST 15-7 DATE 6-1-52 STA. 3-355 TRUCK I & TRAILER 4

	PURPOSE SHOCK		./SEC.	NO.	SERIAL	MAG	OP	ER.	FOC	1.011	
						mro.		D.11.		. LGH.	SERIAL
		<u> </u>	0	E-17	1496				15	5	RC273
	AIETD			20	1525				*		RC313
	VIELD	300	20	12	1512				2	2	RY510
				18	1517				+1		ET415
				า	1443				8	3	ET1229
	<u> </u>			34	1522				.,	•	RC539
	STEM	65	0	27	1514				2	5	RYIBS
	COLOR	40	0	1	1454				'	14	RY183
ND 0,0.5,1.0,1.5,2.0,3.0	LIGHT	80	SEC.	GR-4	670				-	_	
WZS+BARD INT #7-							<u> </u>				
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Rase Front	SHOCK	15	00	MH-I	748	<u> </u>		<u></u>	10	0	BF9465
			<u> </u>	4	745	<u> </u>	L	<u> </u>			BF8525
	CLOUD		<u> </u>	8	744		匚		1		BF 9463
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				R-8	8		13,0	مردو	45	30	773944
				10	!0	ļ	8	300		L	3961
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				31	3!	<u> </u>	5.	7.5			3948
				3	9	ļ	5	<u>s</u>	<u></u>		4694
				33	33	<u> </u>	4	60	1	<u> </u>	3950
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W47 O	M43 ON FELL				BC-6		_		2	54	876312
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#### CAMERA DATA SHEET

TEST TS-7 DATE a-1-52 STA. 3-355

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-VENEZUE BEREIT

CAMERA DATA SHEET 7-248,
TEST\_TS-7 DATE G-1-52 STAS 3-356
TRIXE 2 & TRAILER 5

REMARKS & NOTES			CAMERA		TI	1E		L	NS
PURPOS	SE ∿F?.,SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC	. LGH.	SERIAL
CORE	3000	E-25	1520				IC	2	ETZOI
YIELT.		15	1494				,	•	RCIBS
41		9	1493				6	3	ec 22
FIREB	ALL 9000	F8-3	BC-12				2.9	54	876314
YIELD.		E-16	1513				6	3	ET1245
FIREB	ALL 4000	F16-11	16C-15				10	0	617363
"	1)	F16-R	16-168				•		617367
COLDE	3000	€-8	1445				6	3	ETI254
ND 0,0.5,1.0,1.5,2.0 3.0 LIGHT	80/sec	GR-2	581						
BUS RAP SHUTTER T	- ·	TR-A	3427		C	)	18	29	NEWTONIAN
RAISE FRONT SHO	xK 100	MH-5	743				7	5	BSIBOS
	' "	BH-2	1093				10	۵	282354
HD. O. O. E. I. S. C. O. S. C. C. C. C. C. C. C. C. C. C. C. C. C.	HT 80 /SEC	GR-5	667				-		-
	' *	6	669			Γ-	_	-	_
		R-14	14		10,9	عبرد	48	30	773952
		724	24		13	35			3958
		4	4		44	8			3947
		19	19		49	.2.			2890
		18	18		21	٥			3955
		29	29		78	35	,		3954
LUS SPECIAL F	M.	TR-B	3149 B		~		40	64	CASSEGRAIN
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345 FM TELLER LIGH	47	R-12	12		2	<del>,</del>	46	3/2	773960
l	YED 95,45 (TT 97.6 US)	17	דו	<u> </u>		Ī		ı	3951
5 " "	11 11 23 33 (11 3 10 13)	5	5			<u> </u>	ſ		3956
3 FM TELLER LIGH	<u></u>	6	6	1	1	,	<b>—</b>	-	3949
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CAMERA DATA SHEET

TEST TS-7 DATE G-1-52STAS 3-356
TRUCK 2 (TRUILERS

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CODE			ND	_	LOR	SE	_		RIZ.			L				0	N	OF	F	FN		/EL	_	ZE	20	POS.	NO.
13704	MF		2	17	2	S	6	o.	8	+° ;	33	120	DC	40	80	-1.	55	SEI	-F	27	<u>:</u>   2	∞-	В	5	•	A	E-25
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## CAMERA DATA SHEET

TEST TS-8 DATE 6-5-52 STA. 2-355
TRUCK 2 TRAILER 5
REMARKS 8 NOTES

PURPOSE OFR./SEC. NO. SERIAL MAG. OPER. FOC. LGH. SERIAL

REMARKS & N	IOTES			CAMERA		TII	ME		L	ENS
	Purpose	∼FR./SEC.	NO.	SERIAL	MAG.	OP	ER.	FOC	. LGH.	SERIAL
	CORE	3000	E-25	1520				10	2	ET201
	YIELD		15	1494				,,		RCIB5
	"		9	1493				G	3	RC622
	FIREBALL	9000	18-3	8C-12		Γ		25	4	876314
	YIELD	3000	E-16	1513				ن	3	ET1845
	FIREBALL	4000	F16-11	16C-15				10	0	617363
		n	FIG-R	16-168						617367
	COLOR	OOOE	E-8	1445				G	<del>ა</del>	ET1254
ND 0.0.51.0,1.5,2.0,3.0		80'/sec	GR-2	581					-	
5 MS RAP SHUTTER			TR-A	34.27		7	>	18	ટ૭	HENTONIAN
						Γ				
						Γ			·	
RAISE FRONT	SHOCK	100	MH-5	743				75	 5	851805
	μ	*	BH-2	1093				10	0	282354
MD 0,5,1,1.5,2,3 4381 ± 7	1-2016 5 A LL GHT	801/sec.	GR-5	667				_		
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			24	24	<u> </u>	1	35		i	3958
			4	4-		├──	100		<u> </u>	3947
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			29	29		-	35		-	3954
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	RLY BOMB		5	5		31				3956
	ros		6	<u> </u>		31				3949
5 FM TE	LLER LIGHT			~	<del> </del> -	<del>                                     </del>				2343
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#### CAMERA DATA SHEET

TEST TS-8 DATE 6-5-52 STA. 2-355
TRUCK 2 TRAILER 5

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CAMERA DATA SHEET 4-248 4
TEST TS-8 DATE 6-5-52 STAS, 2-356
TRUCK 1 & TRAILER 4

REMARKS & NOTES		CAMERA		TIME		LE		NS		
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CAMERA DATA SHEET

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APPENDIX B

# FILM LISTING "BLAST STUDIES ON OPERATION TUMBLER-SNAPPER"

A sound movie concerned primarily with the study of blast effects on Tumbler-Snapper has been made and distributed. Table B.1 lists films contained in this movie in the order of their appearance.

In addition to the films listed in Table B.1, this movie contains Rapatronic photographs and descriptive footage shot especially for this picture.

Table B.1 — FILMS CONTAINED IN SOUND MOVIE "BLAST EFFECTS ON TUMBLER-SNAPPER"

			NAME	DATE	J06 N0
			IVAIWE		300 100
FILM #	SHOT #	STATION	Nominal		
13021		F-362.	100 FR/SCC.		
1322	3	7-362	(100		
13806	3	7-361	3000		
13581	4	"	100		
1332,	4	7-362	100		
13383	ų	11	100		
13071	1	F-361	100		
13121	7	7-362	100		
13273	3	7-360	Soo		
1327.5	3	11	SOU		
13276	3	\$1	500		
13277	3	,	Son		
13278	3	"	Suo		
13280	3	7-361	500		
13366	ч	376	36		
13321 (reveat)	4	7-362	100		
13373	4	7-360	500		
13374	ч	"	500		
13085 pre		F- 363	36		
13086 post	1	1 "	36		
13091 pre	1	F-366	36		
13091 pre 13092 post		11	36		
13094	i	F-367	36		
13096		F-368	36		
13018	i	"	36		
13286 pe	3	363	36		
13285 post	3	ч	36		
13198	2	7-375	300		
13288 pre	3	264	36		
13287 past	3	, , , , , , , , , , , , , , , , , , ,	36		
13290 20	3	365	36		
13290 ble	i 3	"	36		
13269	3	7-248	36		
13292 pre	3	366	36		
13291 post	3	"	36		
13296	3	367	36		
13298 pm	3	368	26		
13298 pre 13297 pst	3	и	3/6		
13299	3		36		
13220	3	7-362	100		

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AFPENDIX C

CAMERA-STATION LAYOUTS, TS 1 TO 8

Table C.1 — CAMERA-STATION SUMMARY, TUMBLER-SNAPPER

			1	NAME			CATE	No 110	
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· <del></del>	<del> </del>	F-361		711,000	3133	<del> </del>	In way	<u></u>	ļ
	<del> </del>	F-362	745,826	703,937	3088	<del> </del>	Frack # ?. E	Taciler 85	
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21 2 4 7	<del> </del>	1-36(		700,134	4259	<del></del>	Touch 19 1	Traversy	
	<del> </del>	7-362		6861887	4018	<del> </del>	Trailer #		<del></del>
·	+	1-20-	1835,010	000102	4018	<del> </del>	hauter **	<del></del>	<b></b> -
5	<del>                                     </del>	1.355	831,635	678,359	4103	<del> </del>	Truck #1 4.	Tradie wil	<del> </del>
*************		1.366		671,736	4163	† <del></del>	Tarke 2	11 5	
	1	<del> </del> -	- 131.21	<b></b>		<del> </del>	110000	l	<del></del>
6	4	4.355	846.582	671,736	4163		Truck 2 +	100.5	
	<del>                                     </del>	4-356	863,886		4283	<del> </del>	1	- 4	<del> </del>
	!	1					<u> </u>		<del>                                     </del>
7	3	3-365	\$29.54	695,882	Pion	-	Touch 1+7	wiles 4	
		5-356		695,882	4236	1	" Z	5	
									<b> </b>
8	2	2-355	863,916	668,730	4283		Touck 1 +7	miles 4	
		2-356	878,577	665,909	4507		× Z	" <b>s</b>	
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¥	7		850,284		1040				
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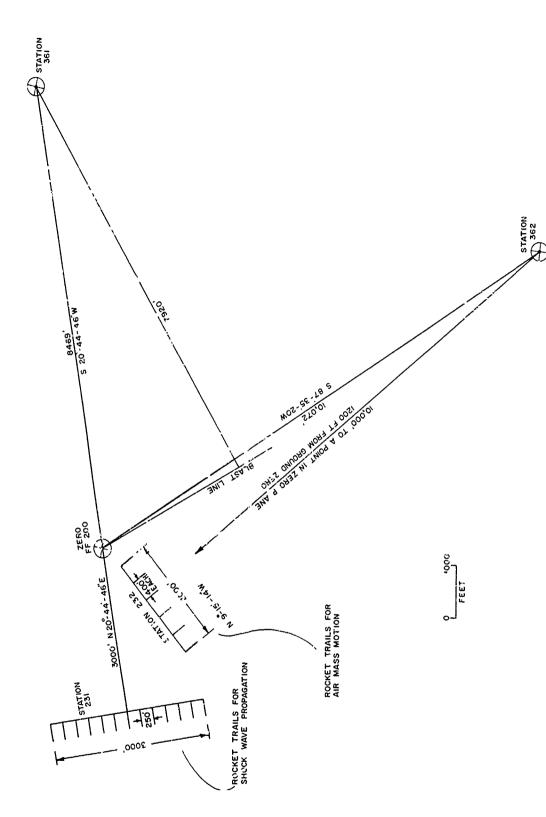


Fig. C.1—Area Flayout, TS-1, Note NOL rucket stations and EG&G camera stations.

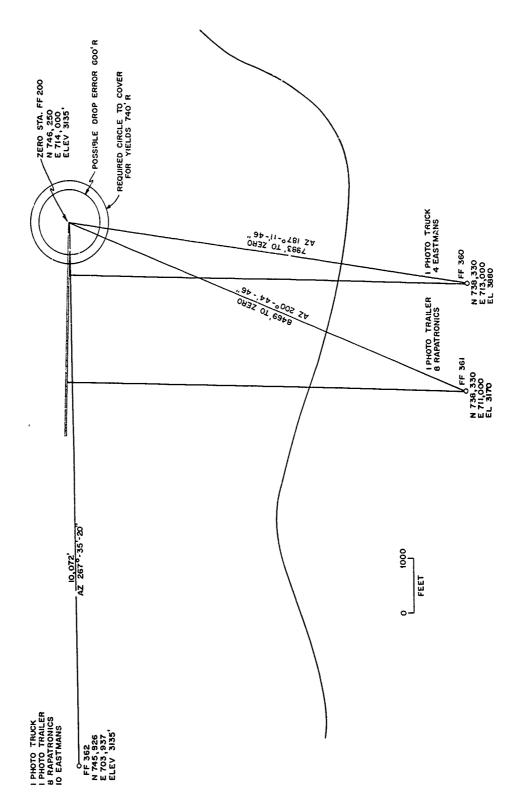


Fig. C.2 -- Photostation layout for yield, TS-1.

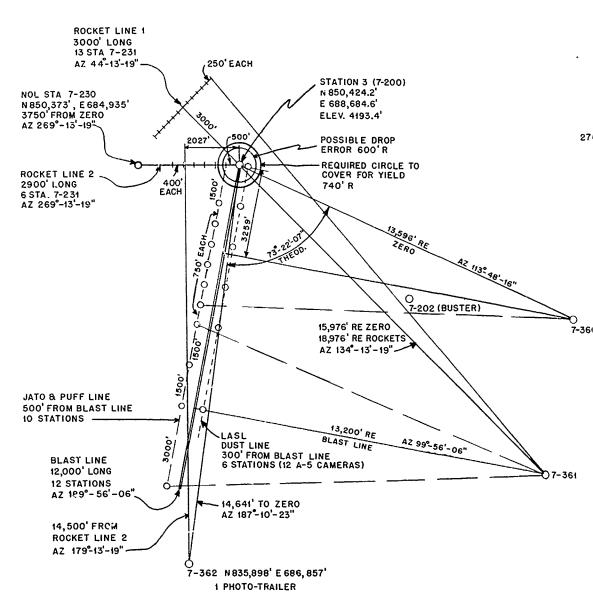


Fig. C.3—Photostation layout, TS-2.

as desittences

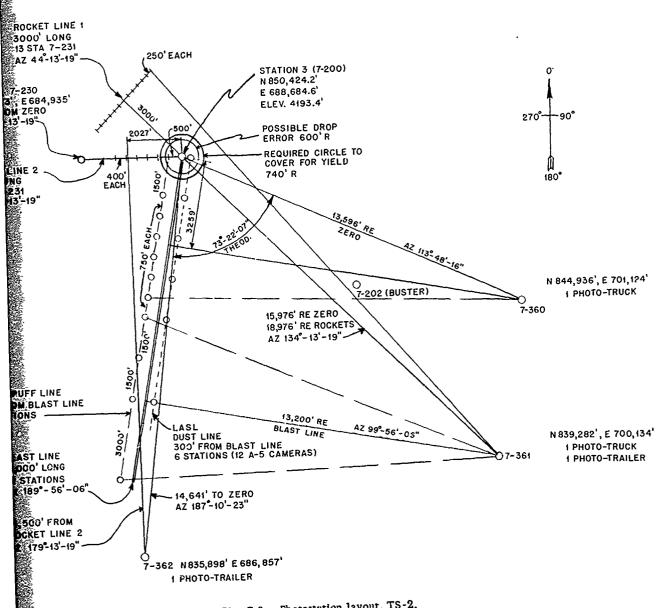


Fig. C.3—Photostation layout, TS-2.

O STA. 7-201 (BUSTER N 860,589 7' PHOTO E 694,967.7' STA.)

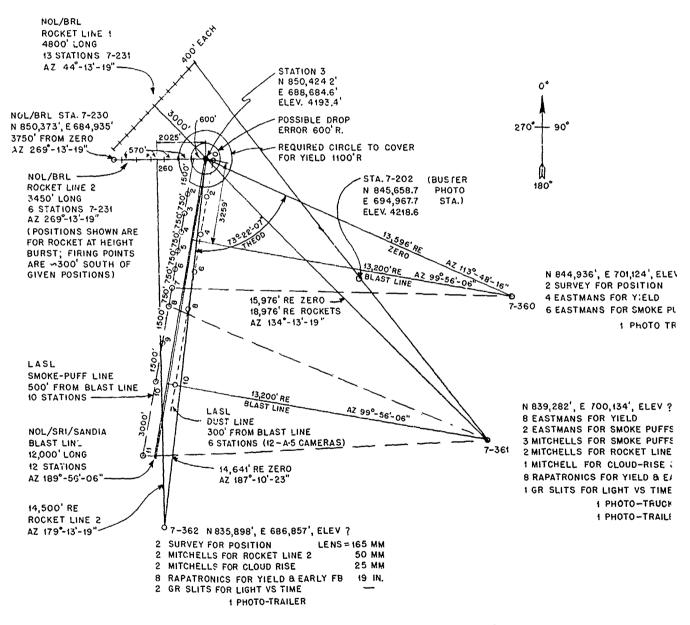


Fig. C.4—Photostation layout, TS 3 and 4.

O<sub>STA. 7-201</sub> (BUSTER рното N 860,589.7 STA.) E 694,967.7' ELEV. 4515.9

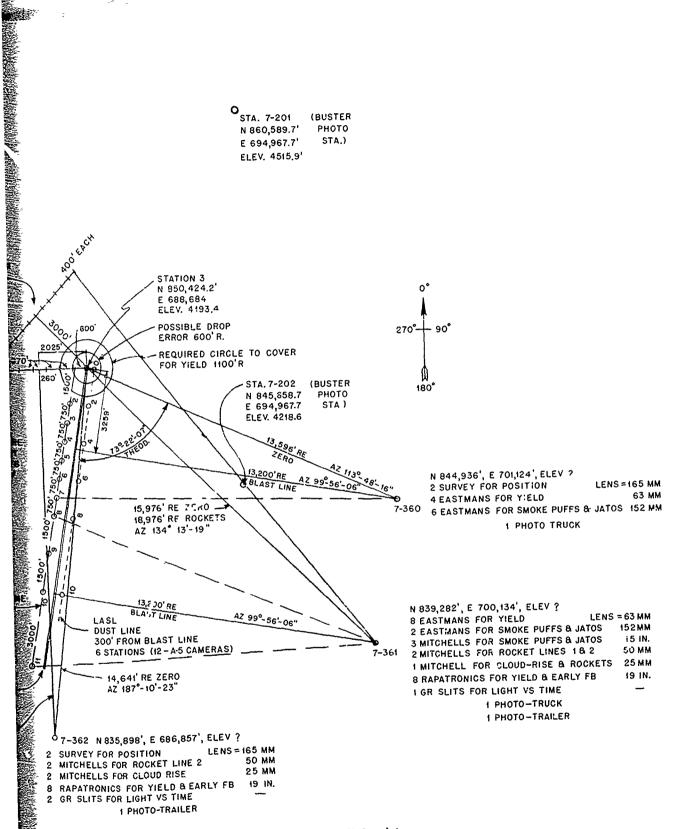


Fig. C.4—Photostation layout, TS 3 and 4.

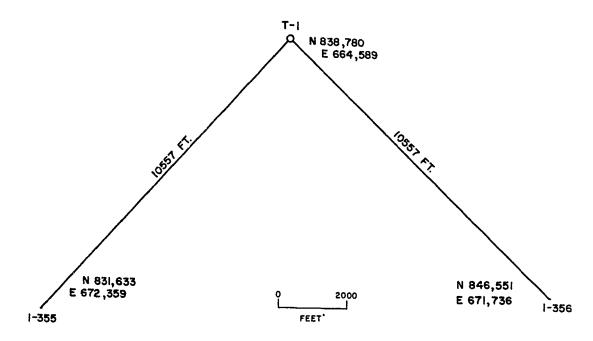


Fig. C.5—Photostation layout, TS-5.

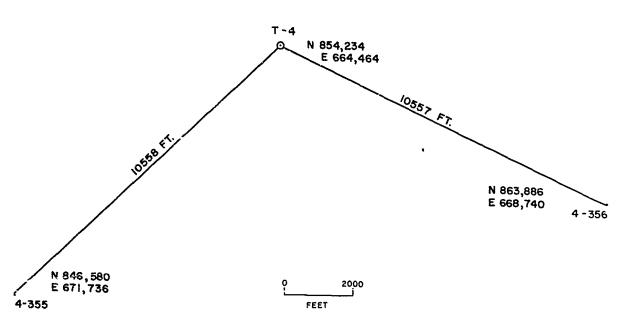


Fig. C.6—Photostation layout, TS-6.

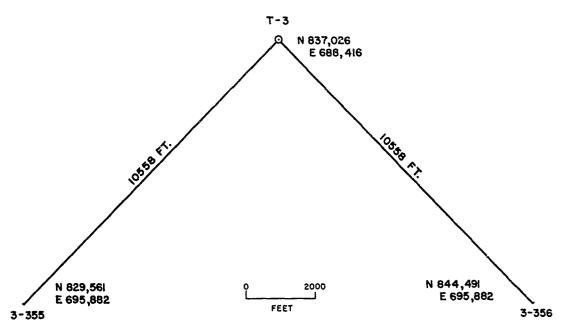


Fig. C.7—Photostation layout, TS-7.

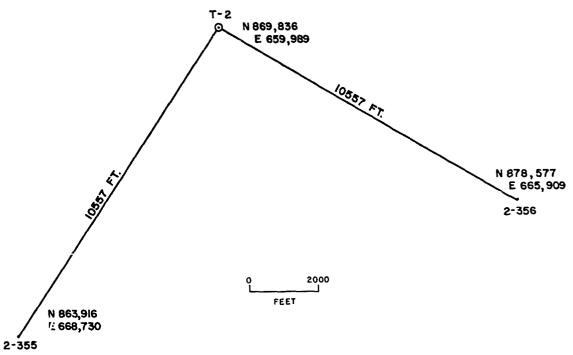


Fig. C.8—Photostation layout, TS-8.

#### APPENDIX D

# CALIBRATION OF EFFECTIVE FOCAL LENGTH WITH COLLIMATOR AND PRISM

This section describes the collimator-prism technique which was used to calibrate the effective focal lengths of the lens-camera combinations. The collimator with its single target and prism essentially replaces two targets at optical infinity separated by a known angle. Figure D.1 illustrates the geometrical properties and nomenclature of the system.

In the ideal case it is necessary that the deviated collimator beam be symmetrical about the photographic axis of the lens. For this case we may write

$$r' = f (\tan \eta/2 + \tan \eta/2) = 2f \tan \eta/2$$
 (D.1)

where r' = the distance between target images on the film

f = the effective focal length of the camera-lens system

 $\eta/2$  = half the total deviation angle of the prism

In the actual case this perfect optical alignment is not possible. The equation of the inner orientation must be written as

$$r' = f(\tan \eta/2 + \mu + \tan \eta/2 - \mu)$$

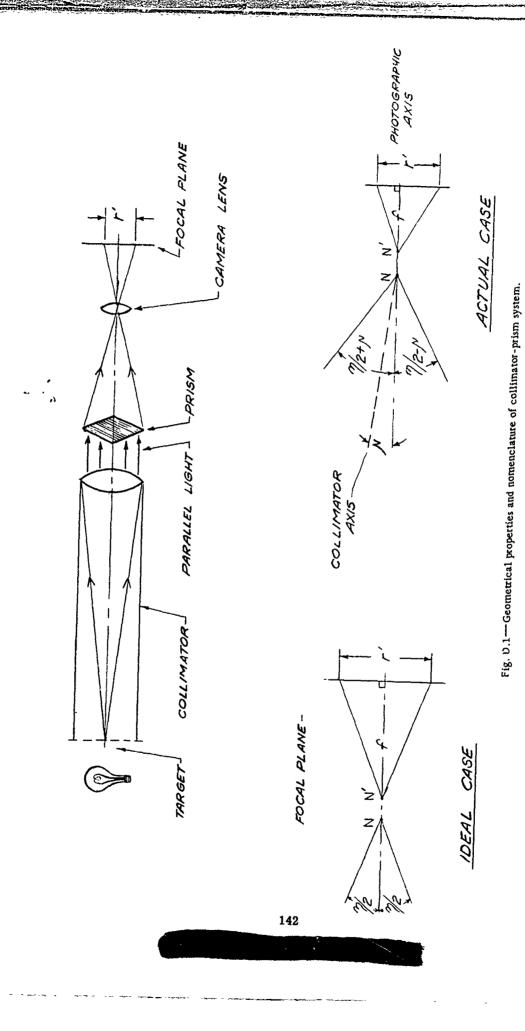
$$= f[\tan \eta/2 + \tan \eta/2 + \mu(\sec^2 \eta/2 - \sec^2 \eta/2)]$$

$$= 2f \tan \eta/2$$
(D.2)

when  $\mu$  is small with respect to  $\eta/2$ .

If reasonable care is taken in setting up the instrument, i.e., if the two collimator images are centered making  $\mu$  small with respect to  $\eta/2$ , then Eq. D.2 breaks down into the simpler form of Eq. D.1.

For the calculation of focal length it is only necessary to measure the distance between the two images of the collimator target on the film and to divide by the parameter  $(2 \tan \eta/2)$  which is a constant of the particular prism being used. Before measurement the film should be conditioned for 12 to 24 hr in an atmosphere of approximately 70°F and 60 per cent relative humidity. The reason for this is to try to eliminate any effects of differential film shrinkage, that is, the difference in the shrinkage of the calibration films and the shot films. The shot films are conditioned in this same atmosphere.



### APPENDIX E

# METEOROLOGICAL DATA, TUMBLER-SNAPPER

Shot	Date	Time, PST	Temp.,	Pressure, mb	Relative humidity, %	Air density	velocity of sound, <b>M</b> meters/ <del>usee</del> See
1	4-1-52	0900:07.5	13.6	888.5	30	1.066	0.3397
2	4-15-52	0929:57.05	9.1	842	30	1.049	0.3370
3	4-22-52	0930:10.02	7.6	770	47	0.9536	0.3361
4	5-1-52	0829:59.1	15.0	845	50	1.018	0.3406
5	5-7-52	0414:59.25	16.6	858	37	1.029	0.3416
6	5-25-52	0359:59.6	19.4	858	41	1.021	0.3433
7	6-1-52	0354:59.8	13.2	865	48.1	1.040	0.3395
8	6-5-52	0355:00,3	20.6	856,5	50.4	1.010	0.3440

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### APPENDIX F

## RAPATRONIC TOWER PHOTOGRAPHY, TS 5 TO 8

Figures F.1 to F.8 are early fireball photographs which create an interesting study, all to the same scale, of the growth of four detonations,  $TS \ 5$  to 8.

Fig. F 1-Fireball photograph, TS-5, 7 May 1352. Camera 2 miles northeast.

and the state of the said

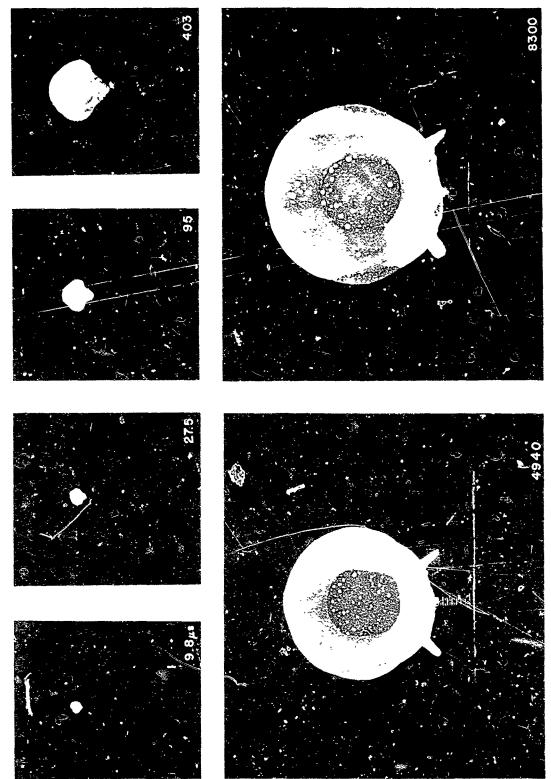


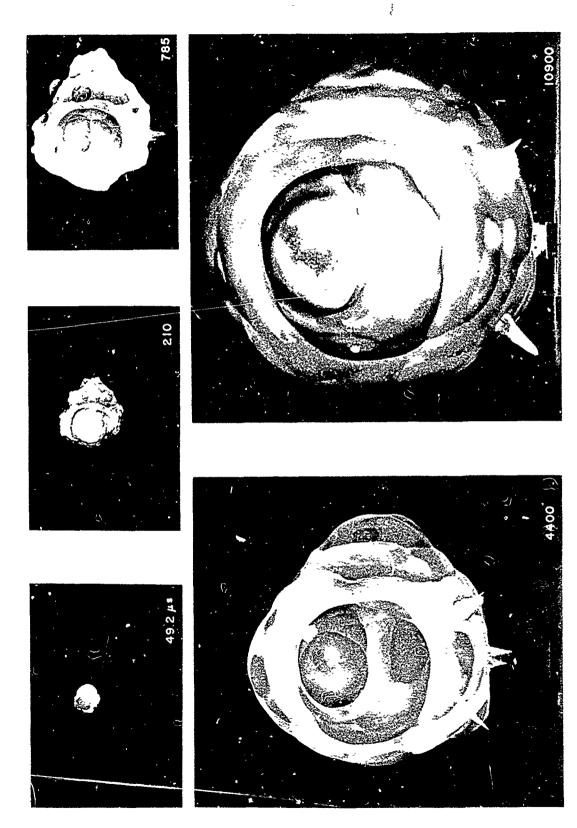
Fig. F.3-Fireball photograph, TS-6, 25 May 1952. Camera 2 miles northeast.

Fig. F.4-Fireball photograph, TS-6, 25 May 1952. Camera 2 miles southeast.

Fig. F.5-Fireball photograph, TS-7, 1 June 1952. Camera 2 miles northeast.

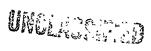
Fig. F.6 - Fireball photograph, TS-7, 1 June 1952. Camera 2 miles southeast.

Fig. F.7-Fireball photograph, TS-8, 5 June 1952. Camera 2 miles northeast.



153-154

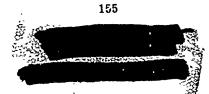




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Jaskierny	5			
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University of California Radiation Laboratory, PO Box 808, Livermore, Calif.,				
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